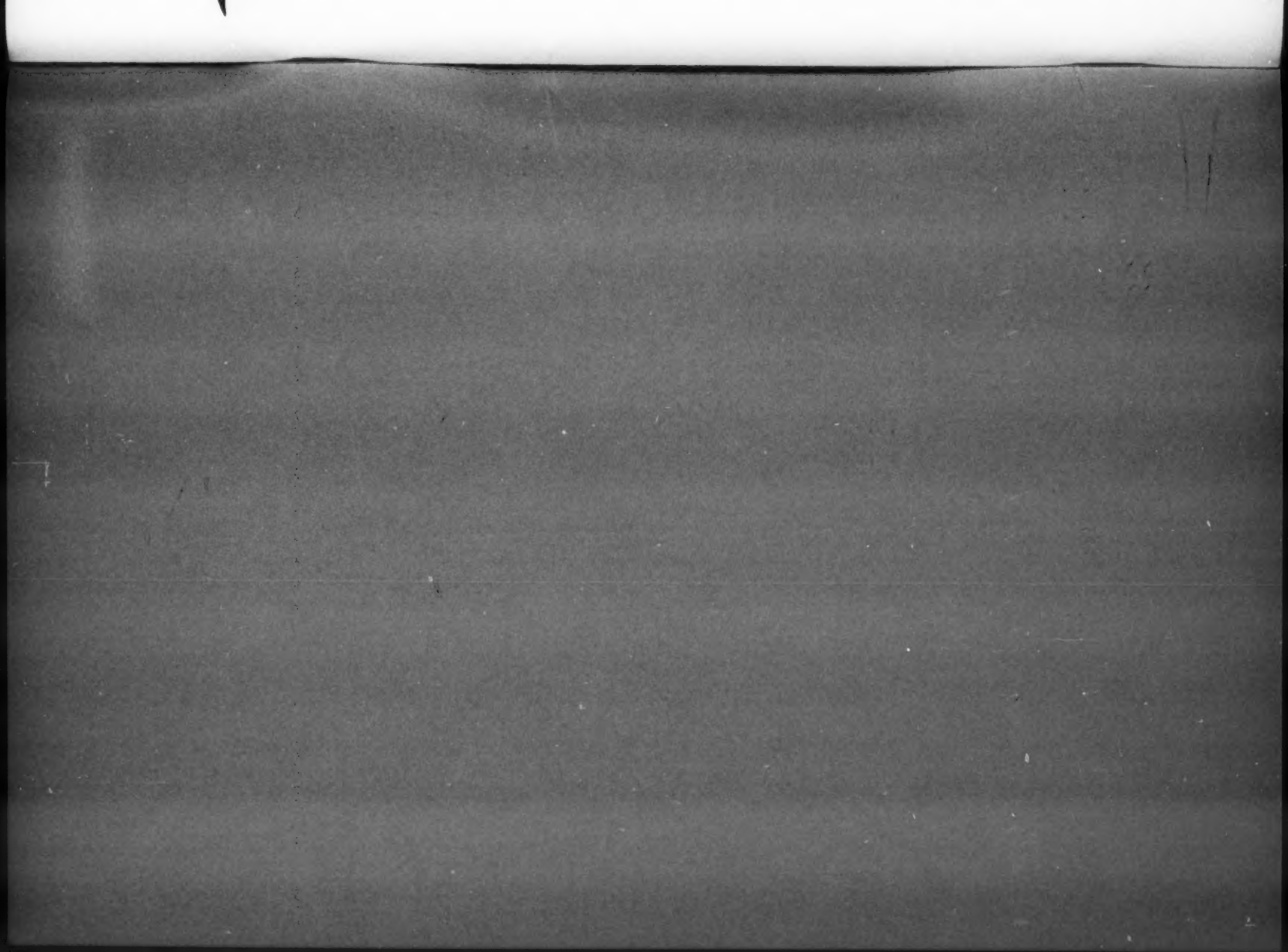
# YEARBOOK of the ASSOCIATION of PACIFIC COAST GEOGRAPHERS

VOLUME 16, 1954
Published by the Association at Cheney, Washington



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Reprinted by Oregon State University Press, March 1970

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# ENGLISH SPEAKING SETTLEMENT OF THE WESTERN CARIBBEAN*

James J. Parsons

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## By Way of Preface

From Herodotus to Heyerdahl the far-off and seldom visited lands that have been but little known or understood have been a particular concern of geographers. The public is still apt to think of geography primarily in terms of geographical discovery and exploration and it is often a bit disillusioned upon learning how seldom geographers actually are concerned with far-away and romantic places and peoples. This, I think, is rather unfortunate. Certainly it was the prospect of satisfying deep-seated curiosities about distant and dimly-known corners of the earth that lured many of us initially into this thing we call Geography, stimulated perhaps by a childhood collection of stamps or rocks or by those wonderful pictures in the National Geographic. When we saw that there was a chance to make a living at this sort of thing we became professionals. In the beginning we have had a good bit of the unabashed hedonist in us. The trouble seems to be that somewhere along the line we "get religion;" we spend less and less time on the problems and areas that really excite us, the things we really would like to do, and more and more time doing the things that we are asked to do or feel we should do, usually because they seem to bear on local and contemporary problems for which answers are being demanded. We start taking ourselves too seriously, we seem to tense up, and we begin to merit the charge of the editor of that excellent new magazine of the human geography of the Southwest called **Landscape** that professional geographers as a group are inclined to be somewhat dull lot whose capacities for wonderment are not being properly exercised. As we concern ourselves increasingly with enumeration and description, we stop asking "why" and "how". What is worse, our descriptions too often lack life and imagination. The dearth of widely-read, semi-popular books on geography in America is in embarassing contrast to the situation in Europe. Nor can all the blame be laid to high publishing costs. Good writing, of course, requires practice as well as imagination and persistence. This may be why newspaper experience has been in the background of so many of our most respected geographers — Ratzel and Reclus, to name two.

In the days when German geography was great, one or more field seasons or **wanderjahre** in an unfamiliar physical and cultural environment in one of

* Presidential address of the Association of Pacific Coast Geographers, Pullman, Washington. June 24, 1954. The field work on which this paper is based was carried out in the Spring of 1953 and was supported by the Geographic Branch, Office of Naval Research.

the further reaches of the earth was almost a requisite of graduate training. To be thrown into the midst of a totally unfamiliar setting, preferably one that has not been picked over too much by the "experts", and faced with the task of pulling together observations into a meaningful pattern and interpretation is certainly one of the best tests of geographical competence. I should tonight like to put in a good word for the thesis that to know ourselves and our own culture such a point of reference in other lands, in other cultures and even other times puts us on much firmer ground. And further, that the time to stake them out is in graduate student days, when enthusiasms and physical endurance are at full strength, before children, house payments, and heavy teaching loads make arm-chair geographers of us by force of circumstances or habit.

At Berkeley, in a certain measure through the influence of Carl Sauer, we have found in Latin America a convenient and relatively inexpensive proving ground for graduate students which has been curiously little exploited by American geographers. It offers not only areas of rich geographical content but enticing problems in systematic geography as well. Moreover, a thesis based on extensive field study in Middle America or the Caribbean frequently has opened the door to a teaching job with course work in Latin American geography, in tropical geography, or in culture history which would have been closed to the candidate whose field experience has been confined to the familiar urbanized industrial North American culture region of the mid-20th century with which we are all more or less inevitably identified. And there is yet another reward from foreign field work; it is an almost sure-fire way to gain a competence of sorts in at least one other tongue than English. I well recall that my own decision to initiate thesis research in Colombia was based in part on the reassuring realization that, if worst came to worst, I would at least come home wth some competence in the Spanish language to show for the considerable expenditure of time and money involved. In Sweden, in Borneo, in Madagascar, or in Brazil the reward would have been comparable.

Our Canadian colleagues seem to be discovering that the Artic regions offer another accessible yet new and challenging environment which sharpens and intensifies their focus. I do not think that it is mere chance that some of the best regional writing on North America has been done by foreigners such as Baulig, Bartz, DeGeer, and Schmieder, nor that some of our own members have done such effective interpretations in Europe, in Mexico, in New Zealand, or the Orient. The stimulus of the new landscape, and the unfamiliar culture, cannot but sharpen the perception of the acute observer; it may go a long way toward explaining why so much of our really enduring geographic literature has been by "scientific travelers," from Peter Kalm, Arthur Young, Humboldt, Wallace, and Darwin to the reconnaissances of Sven Hedin, von Richthofen, Pendleton, Sauer, or Robert Cushman Murphy.

Geography, no more than any other academic discipline, can expect to long endure or command respect as a teaching field alone. In America, at least, this does not always seem to have been properly recognized. Do we really lack the curiosity, the ability to pose problems and to write effective prose that the scantiness of our published researches suggests? Professor Trewartha's stinging critique should be required reading for all who are complacent about the contents of the recent volume entitled **American Geography: Inventory and Prospect.** He writes:

> "A discipline involves a special and particular segment of the whole field of knowledge and those who operate under the banner of any discipline have a dual responsibility which involves the crea-

> tion as well as the imparting of knowledge. Teaching is not enough. It is required of us, also, that we discover new truths and offer new interpretations. This is research, and no discipline can be considered in a healthy state unless its member are both creators and teachers." (1)

As Profesor Trewartha disconsolately observes, we are in general operating with great success at teaching and administration, at text-book writing, at committee work, and a University "politicking", and in general leading energetic lives eagerly devoted to good works. Yet, as we beat the drums for the undeniably high educational values of geography to build up budgets and enrollments, our scholarly activities and thus our academic reputations suffer accordingly. If we are to defend our place of honor within the tradition of liberal learning we must pay more attention to the cultivation of the critical and exploratory spirit, concern ourselves more with additions to knowledge and become once more creative thinkers and intellectual pioneers. Such an asssociation as this has a definite responsibility to further the attainment of such goals, to encourage expertness and depth in a field that has become increasingly characterized by shallowness. Only by charting such a course can we hope to attract the superior young students in whose hands we would like to see the fate of geography eventually rest.

But we shall be known by our works and saved by them alone. With this in mind I turn now to a summary of my current field and library research into the Geography of the English-speaking, Protestant Settlements of the Western Caribbean. It is not a problem, nor an area of any particular practical significance at the moment, nor did a desire to demonstrate any particular "field method" motivate my visit to the area. I went there for the old-fashioned reason that it interested and intrigued me and because it was one of those blank spots on the map and in the literature that seems never to have received much attention. What I found whetted my curiosity and has sent me scurrying back to the library for the answers to many questions which can only be found by the collation of field and documentary evidence.

## The Western Caribbean

The Caribbean coast of Central America is a low-lying and reef-strewn shore exposed to the full brunt of the northeast trades and, except for Chiriquí Lagoon, almost devoid of natural deep-water harbors. Behind the sandy beach ridges lie mangrove swamps and behind the swamps a sparsely inhabited tropical rain forest or, on the gravel terraces of the Miskito Coast, a surprisingly extensive area of pine savanna. The soils are generally leached and sterile, for the mantle of volcanic ash which supports the dense populations of the interior highlands is entirely lacking. This is one of the really rainy portions of the earth. Annual precipitation exceeds 100 inches almost everywhere south of Belize, reaching a maximum of over 250 inches between Bluefields and Limón. The dry season is pronounced in the north, less so in the south. In Köppen terminology it is **Af.** Only on the offshore islands is the rainfall moderate. Yet, contrary to popular opinion, this is not an unhealthy or unattractive coast. In times past it had something of a reputation as a tropical sanatorium. For much of the year there is a persistent onshore breeze which lowers the sensible temperature appheciably. The anopholes mosquito is a collector's item. Only the sand flies at Cape Gracias á Dios are noisome. Except for Colón and some of the American-built banana towns which have their own modern water systems, this is a "cistern coast" and is thus one of the few areas south of the Rio

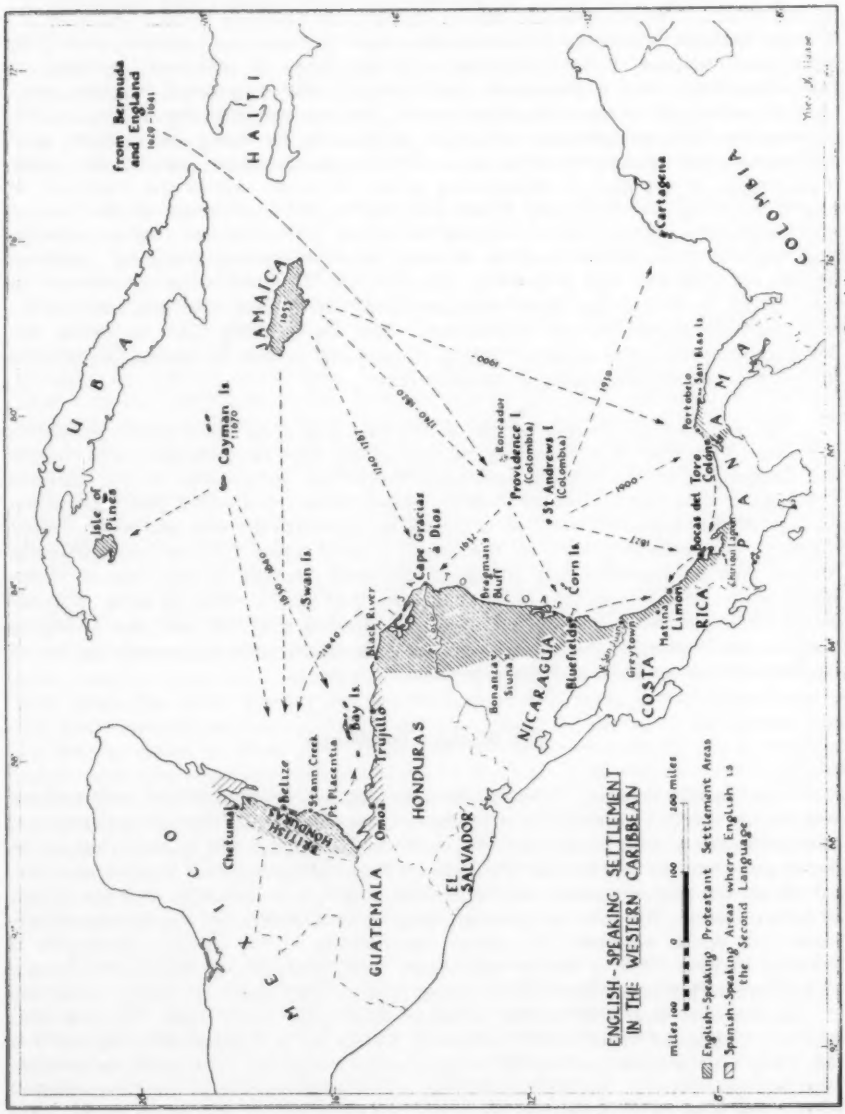


Figure 1. English-speaking settlement in the Western Caribbean.

Grande where the drinking water is usually safe. From Mérida to Darien and on most of the islands domestic water is obtained not from wells, nor from open streams, but from the housetops, collected in concrete tanks, in old rum puncheons or even in dug-out canoes placed under the eaves to trap the runoff from each passing shower from the palm-thatch or corrugated-iron roofs.

For the history of the Western Caribbean the islands are of special importance for they have served both as stepping stones to mainland settlement and, in later times, as cultural museums of a sort where the attractive and leisurely way of life of an earlier era of sail has somehow been preserved. None of them is large but all except the low coral-sand keys off the British Honduras and Miskito coasts are inhabited. The Bay Islands of Honduras are drowned ramparts of the east-west trending folded mountains of the mainland which re-emerge as Jamaica some 500 miles to the east. Coconut-covered Corn Island, with Little Corn to the north, is composed of porous lavas which have weathered into a rich red soil with a gentle surface relief. Providence is an imposing volcanic plug towering 1,100 feet above the sea, wheras St. Andrews, Swan, and the Cayman Islands are relatively low, massive blocks of Tertiary limestone.

These isolated and forgotten islands, together with the adjacent mainland coast and Jamaica, comprise an English-speaking, Protestant enclave within a Spanish-speaking, Catholic world. It has been delimited by shading on Figure 1. From Chetumal and Kingston southward to Panama, English is spoken either as the mother tongue of a substantial segment of the population or as the **lingua franca** which is understood when all else fails. True, relatively small numbers of persons are involved—if Jamaica is excluded, for the total for the total English-speaking community of the Western Caribbean probably numbers less than 300,000, but the extent of the area occupied give them an importance disproportionate to their numbers. The origin of so substantial an area of non-Spanish culture within the conventional limits of Latin America and the explanation for its tenacious persistence in the face of rather imposing odds presents an intriguing problem in historical geography which has attracted curiously little attention.

## Early English Activities

The Spaniards' studied avoidance of this low, rainy coast and its unruly native populations made possible the original English settlement in the early 17th century. To Spain this was marginal country, both difficult and profitless to hold in force. Between Chetumal Bay and Portobelo the only permanent Spanish establishments during most of the Colonial Period were the fortified ports of Truiillo and Omoa on the Bay of Honduras. These served as ports of entry and exit for the more densely settled highlands of Guatemala, Honduras. Nicaragua, and Costa Rica where both tractable Indians and precious metals were abundant and where the cooler, drier climte was more to the taste of the Spanish gentry. These were the compelling attractions rather than any recognition of the eventual possible value of a securely held Central American isthmus. Spain became concerned about the Central American threat only toward the middle of the 18th century after the English, in alliance with the Miskito Indians, had become firmly established all the way from Belize to Chiriquí Lagoon. By then it was too late to move against them.

The initial English stirrings in the area, apart from the maraudings of

Hawkins and Drake, were at Providence and St. Andrews, some 100 miles off the coast of Central America and 350 miles south of Jamaica. These unoccupied islands, "pointing like a dagger" at the heart of Spain's New World possessions, were colonized in 1629 by a joint-stock company of London Puritans which planted white yeoman farmers here, at first from the failing Bermuda colony and later from England and from Massachusetts Bay.(2) The principal settlement was on the more northerly island, called Providence by the English but shown on earlier Spanish charts since at least 1527 as Santa Catalina. The name Catalina is reserved today for the rugged northern point of Providence which is separated by a narrow tidal channel from the main basalt massif to the south. St. Andrews, 50 miles to the south, was used as a source of cedar for shipbuilding but seems to have supported only temporary settlements during this early period. It was more difficult to fortify and, perhaps more important, it lacked the perennial streams of mountainous Providence.

Split by theological bickering and isolated from all other British Caribbean settlements, the Providence colony was a financial disappointment. Nor did the introduction of Negro slaves, reluctantly resorted to in 1634, improve the situation. As it became evident that there was more to be gained in taking Spanish prizes than in growing tobacco or cotton the island gradually was converted into a fortified privateering base. Increasingly a thorn in the side of the Spaniards the Providence English were expelled by a Spanish invasion force from Cartagena in 1641. The London investors, at the time engrossed in parliamentary struggles, made no moves to retrieve their losses but they had established an English interest in the Western Caribbean and set the stage for the occupation of Jamaica in 1655. Cromwell's ambitious "Western Design", which would have made the Caribbean a British sea, was apparently much influenced by the leaders of the Providence Company for whom war upon Spain was looked upon as a form of revenge for their personal losses as well as an established principle of religious duty.

The Providence colonists had focused English attention upon the mainland. As early as 1632 trade relations had been established with the Miskito Indians at Cape Gracias á Dios, the Dutch buccaneer Bluefields serving as intermediary. A mutual antagonism towards the Spaniards helped cement a friendly relationship between trader and native. The Indians were superlative boatsmen and their talents were soon channeled by the English into small-scale raiding expeditions against the thinly-held Spanish coastal establishments. To the northward, on the Coxcomb Coast of Belize, logwood was found growing in abundance and this valued dyewood soon became the principal concern of the Providence men who went to the "Bay" to trade and to raid. Trading posts or "stands" were established at numerous points along the coast, as at the mouth of the Belize River, at Stann Creek, and at Point Placentia, and there were further augmented by refugees after the fall of Providence itself in 1641.(3) Under a formal patent issued by the Providence Company, a settlement had been established three years earlier on Ruatan, the largest of the Bay Islands and almost within sight of the Spanish fortress of Trujillo.(4) Although it was short-lived, it marked the beginning of nearly 300 years of English interest in the Bay Islands, whose history is so intimately interwoven with that of the colony of British Honduras. British claims to the English-speaking Bay Islands were finally quieted by a treaty with Honduras in 1859.

On the Miskito Shore there was no logwood, but there was business of another sort. Cacao, gold, and slaves hijacked from ill-defended Spanish

bases between Yucatan and Panama by stealthy Miskito Indian raiders were received by the English traders on the shore in exchange for gunpowder, rum and calico. For more than 100 years the harassed Spanish colonies of Central America schemed and plotted to eliminate the "zambo and Mosquito scourage" and their English inciters, but the all-out ettort was never made. In the shallow waters of this exposed coast it was clear that the clumsy Spanish men-o-war would be no match for the fleet dug-outs manned by a dozen Miskito men to whom these waters were as familiar as the palm of their hand. Trujillo and Omoa were favorite raiding objectives; so was the Matina cacao district of Costa Rica which was regularly visited with such success that the government in San José in the end sued tor peace, offering substantial bribes to the Indian leaders if they would only leave the coastal plantations alone.(5)

**Changing Settlement and Control**

With the occupation of Jamaica in 1655 the Bay and the Shore colonies had become economically and politically dependents of the Jamaica government. Such additional settlers as arrived usually came by way of Port Royal, and Kingston. There were British settlements at Black River, Cape Gracias, Bragman's Bluff, Corn Island, and Bluefields, on Ruatan, the Caymans, and at several points along the Belize coast, perhaps extending northward into Yucatan and Campeche. Mahogany had replaced logwood as the principal export from these mainland British settlements by 1770, but sarsaparilla, tortoise shell, and green turtle meat were also of some importance.(6) Then abruptly, in 1786, in a treaty signed in far-off Madrid, England agreed to evacuate all of its settlements on the Bay Islands and the Miskito Shore. In view of the strength of the long-established British positions on the shore and the relative ease with which Spanish-America might have been split in two by a campaign across the Isthmus by the Rió San Juan route and the Nicaraguan lakes, the Treaty of 1786 appears as a most remarkable document. This may have represented the first voluntary withdrawal of Great Britain from any land over which the British had flown. But the concessions were dictated by events in Europe rather than any precariousnes of the English toehold on the mainland of Central America. After the evacuation, completed in 1788, the Miskito Shore and the Bay Islands remained deserted of Europeans for nearly 30 years despite several half-hearted Spanish attempts to settle colonists from Spain and the Canary Islands. The largest number of the evacuees, both free men and slaves, were removed to Belize where, with the descendents of the Providence and Jamaica logwood cutters already there, they formed the nucleus of what was to become the colony of British Honduras.(7) It was soon further augmented by the "Black Caribs", with their unique Afro-Indian culture, whom the British had evacuated from the Caribbean island of Granada to Ruatan at the end of the 18th century.(8)

Meanwhile Providence, after serving briefly as a staging base for Henry Morgan's 1670 raid on Panama, had been abandoned by both Spanish and English. So had St. Andrews. But the islands had not been forgotten, and sometinme before 1742 Englishmen from Jamaica were reported permanently residing on the islands, planting cotton and cutting cedar.(9) With Spain and Great Britan on more amicable terms, fortifications seemed less important and it was St. Andrews rather than Providence that now received the principal attention. Ties with the Miskito Shore were ineviably close. The 1786 treaty would have spelled the doom of the island settlements but for the successful petition by the 220 residents of St. Andrews to the Spanish Crown requesting special permission to remain on their beloved island and offering to become

loyal subjects of the King of Spain, to accept the Catholic religion and to cease trading with Jamaica.(10) To the Spaniards it must have appeared that at least a nominally friendly and peaceful settlement of English under Spanish rule was more desirable than that the islands should be left unoccupied or garrisoned by Spanish soldiers.

If cotton was the principal crop, contraband appeared to have been the principal activity of the islanders, the agreement with the Crown to the contrary notwithstanding. The islands now became a base for resuming the old trade with friendly mainland Indians who had been for so long the military allies of the English. There was illicit commerce with the Spanish settlements, too. On St. Andrews the population had increased to 1,200 in 1806. Many of these were Negro slaves, evacuated from Bluefields and Corn Island. Commercial and cultural ties continued to be with Kingston rather than Cartagena. The Governor wrote in 1803 that "the inhabitants (of St. Andrews) still speak the English language without any knowledge of Spanish; several youths of both sexes have been permitted to travel to England and the United States . . . of the Catholic religion they have no idea . . . of Christianity they know nothing but baptism."

On Providence the Negro element was less conspicuous than on St. Andrews. For one thing, Providence was an important base for hawksbill turtling and turtling was traditionally a white man's job. In later years, as the Cayman turtlemen shifted from Cuban waters to the Bay Islands and the Miskito keys, Providence became increasingly a port of call for the turtle boats. There is still a strong white Cayman element in the population of the Bay Islands and a lesser one in Corn and Providence. Since about 1880, however, emigration from the Caymans seems to have been largely redirected towards Belize and the southern United States.(11) Another factor contributing to the whiteness of the Providence population, when compared to neighboring St. Andrews, has been its recurring role as a pirate base. Privateering, too, was a white man's business. Especially between 1817 and 1820, when the Frenchman Luis Aury was operating out of Providence under the flag of Buenos Aires and Chile, it was an active melting pot, although Frenchmen and Haitian creoles predominated.(12)

The claim of the Republic of Colombia to St. Andrews and Providence dates from an 1803 **real orden** which had placed the island under the Viceroyalty of New Granada, with administration through Bogotá and Cartagena. Nicaragua later was to argue that the islands were properly a part of the Miskito Shore which she had inherited from the Central American States, but Colombia's claim was never more than nominally contested and was finally formally recognized by Nicaragua in 1928. At the same time, the Bogotá government vacated its claims to the Corn Islands, claims that were fully aired only after Nicaragua granted the U. S. a 99-year lease on the island during the trans-isthmian canal negotiations.(13) Although recent National Geographic Society maps still show the Corn Islands as "leased to the U. S.", the lease is of dubious validity inasmuch as the Nicaraguan Canal was never built. In any case, the lease has never been taken up, and neither U.S. officials in Tegucigalpa nor the coconut farmers of the Corn Islands seem even to be aware of its existence. Evacuated as a result of the Treaty of 1786, Corn Island had been gradually resettled after 1800, chiefly by families from St. Andrews who found its volcanic soils productive of cotton and its location convenient both for the contraband trade and to the turtling grounds.(14)

Gradually, and especially after the Latin American Wars for Independence, English settlers filtered back to the Miskito Shore. A major settlement attempt by highland Scots at Black River between 1820 and 1824 was abortive, (15) as another Scottish colony at Darien had been 130 years earlier, but gradually turtlers, traders, and mahogany cutters from Jamaica, Belize, and the Caymans re-established the primacy of British interest in the Bay Islands and the Miskito Shore. Bocas del Toro had been founded by disgruntled St. Andrews settlers in 1827. At about the same time the Bay Islands were being re-settled by Cayman families who were finding their small island too crowded. Others went to Belize and to Cuba's Isle of Pines. Scheming to capture the Atlantic terminus of the proposed Nicaraguan Canal was involved in both in the establishment of Greytown at the mouth of the Rió San Juan as a major focus of British interest and the creation of the preposterous, British-sponsored and protested Miskito Kingdom (1860-1892) under a Royal House of barefoot zambos who were crowned and anointed in drunken orgies by the Superintendent of the Belize colony.

## Yankee Traders and Adventurers

Americans, too, entered the picture increasingly. By the 1820's schooners from Boston, New York and Baltimore were carrying on a substantial trade with the mainland south of Cape Gracias á Dios, at that time claimed by the Colombian government. Until the middle of the century, St. Andrews' only cash crop was long-staple cotton, most of which found its way into U.S. markets. Stimulated by a growing American demand and coincident with the abolition of slavery, a coconut craze swept the island until the last of the cotton had been replaced by the graceful palms which today make it one great seven-mile long coconut garden. As the price rose, the newly liberated blacks acquired economic independence and even prosperity. The nuts were loaded by homeward-bound Yankee trading vessels, usually for the account of the Franklin Baker Company of Hoboken, New Jersey, and Philadelphia, which maintained resident buyers both on St. Andrews and on Corn Island.(16) It has only been during the past 20 years, assisted by a stiff Colombian protective tariff, that the nuts, now in the form of sun-dried copra, have been marketed in Cartagena. On Corn Island, the oil is extracted from the copra and shipped in drums to the port of Bluefields from whence it is flown by air cargo to the Managua market.

Other Americans, stragglers from the rush to or from the California gold fields, were settling along the Panama and Nicaragua routes between the two oceans. A scheme for establishing a home for freed Southern slaves somewhere in the Chiriquí Lagoon area, a sort of American Liberia, for a time was given serious consideration by Abraham Lincoln and Secretary Seward, but the project came to naught.(17) Other colonization schemes by Germans, French, Belgians, and United States Confederates were hardly more successful. Much later, in the 20th century, U. S. military intervention in Nicaragua and in Panama was to open the way for other American adventurers and filibusters to settle along the Caribbean coast of Central America.

Bananas, first on the Bay Islands, then in the Bluefields area and at Chiriquí Lagoon, began to be produced under American direction for export to the United States after 1875. For a time Bluefields, with an English language daily and frequent steamship service to the Gulf ports, was one of the major out-

posts of Yankee "Manifest Destiny" in the Caribbean. "We only need a Rhodes," a Bluefields editor wrote, "to make us the counterpart of Johannesburg".(18) Rubber, bananas, gold, mahogany, and pine lumber have each in turn been the basis for new hopes and enthusiasms but plant disease, reource depletion, unstable governments, banditry, and labor shortages have alway combined in some fashion to deflate each new boom before it has gotten well underway. Today Bluefields slumbers on, its unpainted clapboard houses ridden with termites. It is separated from deep water by six-miles of silt-choked bay, one of the least visited and most forgotten ports of the entire Caribbean area. Limón, linked to the interior by the only railroad crossing the isthmus between Tehuantepec and the Canal Zone, has prospered only slightly more. The banana companies have been constantly on the move, dodging Panama and Sigatoka disease and, more recently, labor difficulties and expropriation. The Limón area, like the Bluefields area and Trujillo, has been abandoned but Bocas del Toro and a part of the Honduras coast have again come to life, thanks to the new technique of flood-sterilization against fusarium. The banana operations have attracted thousands of British West Indian laborers as well as sizeable staffs of American administrators and technicians and their families who further augment the English-speaking populations of the coast.

**Recent Changes**

The building of the Panama Canal, and the Panama Railroad before it, has been responsible at least indirectly for most of the later English-speaking settlement of the Central American coast. Canal construction jobs, first under the French and later under the Americans, bought West Indian Negroes to Panama by the thousand after 1896. Probably the majority of them remained. Colón is today an English-speaking Suez of 40,000 population within the Republic of Panama. Within the Canal Zone, which includes the American towns of Cristóbal and Balboa, there were 52,000 residents in 1950 of whom 25 per cent had been born within the United States, 5 per cent in the British West Indies, and another 10 per cent in the Canal Zone itself. And then there are the Colombian islanders. It is quite probable that there are more natives of St. Andrews and Providence islands living in Colón and within the Canal Zone than on the islands themselves. Almost everyone on the islands has lived and worked at one time or another at Colón although recently the oil fields of the Magdalena River valley in Colombia have attracted growing numbers of island job-hunters. Once the canal was built many of the West Indians, of whom Jamaicans were in the majority, moved north along the coast to banana and cacao plantation jobs and to construction work at Bocas, Limón, or Bluefields Even today the Kingston **Daily Gleaner** is old on the street corners of Colón and Limón. Jamaicans are recognized everywhere as the superior farmers, in contrast to the local "creoles" who are by tradition the woodsmen, the mariners, the turtlers, and the traders.

Briefly, in the early 1900's, the apparent strategic value of some of the lesser islands, coupled with the natural inclinations of the English-speaking inhabitants and the prevalent imperialism of the day, seemed likely to put them into the hands of one or another of the great powers. The inhabitants of Corn in 1894 had petitioned without success to become subjects of the British Crown.(19) A few years later, Nicaraguan Liberal leaders were offering the island to Great Britain as a coaling station if she would agree to intervene and protest against U. S. intervention. Instead, it was leased to the U. S. as a base from which to protect the approaches to a canal which was never built.

Isolated Swan Island, claimed by both the U. S. and Honduras and intermittently occupied by a few British subjects from the Cayman Islands became a relay station for the United Fruit Company; more recently it has been occupied by the personnel of a U. S. Weather Bureau station. During World War I there were reports that the Japanese were negotiating for Roncador Cay, an uninhabited reef 100 miles northeast o Providence, as a fueling station.(20) Earlier one of the Taft administration's unsucceessful proposals to Colombia in the Panama indemnification case would have given the United States a perpetual lease to Providence and St. Andrews.(21)

Where aboriginal populations and cultures have remained more or less intact, as with the Maya of British Honduras, the Miskito, the Talamanca of Costa Rica and the Guaymí and San Blas Cuna of Panama, English rather than Spanish is normally spoken by those who command a second tongue. It will thus be observed that the mainland areas shaded on the map include substantial areas which are but sparsely occupied by native populations who have long been under the influence of English and American traders and missionaries. Work on plantations, in lumber camps, aboard ships, in the gold mines, has brought them into association with English-speaking neighbors. The Christian missions, both Catholic and Protestant, which have been active in the area for over 100 years have always been largely manned by Americans and Canadians. The gold camps at Bonanza and Siuna, inland 80 miles from the coast in Nicaragua, in recent years have helped push the boundary of English-speaking settlement further westward south of the Rió Coco. So have the forest industries, mahogany, pine, caucho, and chicle substitutes, which have from time to time flourished under American supervision, with coastal "creoles" or local Indians supplying the work force.

There is a feeling of kinship relationship and a community of interest which still stretches from Belize and Kingston to Bocas del Toro and Colón, but nationalist inspired legislation recently has been imposing increasing restraints and restrictions on the normal cultural and commercial relations and mobility of these peoples of such similar background. Though Negro genes predominate there has been much mixing on the beaches for 300 years, and both white and Indian blood are well represented. So, to a lesser degree, is Chinese. As an island doggerel puts it: "Some is white and some is black, but most's da color o' chawed tabac."

The whitest spots on the map are the smaller islands, except for St. Andrews, where cultural conservatism and inbreeding is especially pronounced. The widespread incidence of deaf-mutism on the Caymans and especially on Providence is apparently the tragic but inevitable consequence of long consanguinity in such close quarters.(22) Relatively few surnames are found within the area and most of these are conspicuously localized geographically, suggeesting that a relatively small genetic stock has been involved. Thus, among the more common names, one associates Jackson and Bodden with Grand Cayman, Archbold and Robinson with Providence, May and Hooker with St. Andrews, Lampson and Hodgson with Bluefields, Brown and Shepherd with Bocas, Quin and Campbell with Corn Island, and Cooper and Kirkconnell with the Bay Islands. Although in many cases slaves, took the surnames of their owners, many of the recurring names tend to be associated with what are locally known as "clear" or "fair" complexions, or more grandly, with "high blood".

**Cultural Persistence and Political Reality**

The staunch cultural particularism of the islanders and the mainland "creoles", their passive resistance to incorporation in the Spanish speaking, Catholic society and culture to which so many of them owe political allegiance, is something that Latin Americans have generally been unprepared either to comprehend or to cope with. Certainly there is today little understanding or sympathetic concern for these English-speaking Protestants within the government offices of Managua, Tegucigalpa, San Jose, Panama, or Bogotá. The rising tide of nationalism, coupled in some instances with improved communications, has tended to make the very existence of the "creole" increasingly a source of embarrassment and discomfort to the home government. Although campaigns to force cultural conformity on these coastal and island peoples have as yet had little effect, they may have somewhat dampened the enthusiasts for independence in Belize, where Guatemala would most certainly press her claims should the British withdraw.

The schools yet provide the opening wedge for Hispanization. Legislation requiring that elementary school instruction be in Spanish, forced shutdowns of Protestant Mission schools and the steadfast refusal of the minor government officials sent out from the interior to use "that dog language, English" have recently placed the "creole" culture more than ever on the defensive, most conspicuously on th Colombian islands. But the signs on the streets in Bocas which read "Hablemos Castellano, somos Panameños" seem to have been no more effective than the repeated but futile Colombian decrees outlawing the use of English place-names on Providence and St. Andrews, and ordering that they be replaced by their Spanish equivalents. At the end of the 18th century, the governor of St. Andrews Island, an Irish-Catholic from the Canary Islands by the name of O'Neille, strongly urged Cartagena officials to send more Spanish soldiers, priests, school-teachers, and petty officials to the islands to hasten the process of assimilation.(23) Today, over 150 years later, the same proposals are being made, this time by the Colombian government in Bogotá, and it is being met with the same quiet opposition which has been responsible for the preservation of this distinctive culture through nearly two centuries of what has amounted to colonial rule.

Continuously since the original settlement of Providence in 1629, there has been an English-speaking, Protestant settlement in the Western Caribbean. Predominantly Negroid, it nevertheless includes a substantial white component and, on the mainland, several sizeable Indian groups. Unfortunately, the climate of Latin America nationalist opinion today leaves little room for a second church, a second language, or a second culture. This cultural imperialism in reverse reflects, in part, the inferiority complex so characteristic of the countries south of the border. It has been partially motivated, no doubt, by an unconscious desire for revenge against the Colossus of the North taken out on these English-speaking communities within Latin American political jurisdiction whose language and religion, at least, are symbolic of the Yankee. There seems to be little chance that the equivalent of a French Canada, where a minority group is encouraged to retain its own cultural and regional identity. will be permitted to develop here. In recent years improved communications

have sharply reduced the English-speaking majorities in the Limón area and may soon do so around Bluefields and Bocas. Downslope migration of settlement from the overcrowed highlands is being aided by highway construction and new airline services. The arch-conservative islands, with their strong maritime and puritan traditions, will probably be the last hold-out areas. The 6,700 inhabitants of the Caymans are, of course, safe under Jamaican rule, but the 8,000 Bay Islanders, the 2,000 on Corn, the 2,000 on Providence and the 4,000 on St. Andrews are all under various degrees of pressure to conform to the Latin norm. Poor but proud, they can boast of nearly 100 per cent literacy and a higher standard of living than the mainlanders enjoy. For their lovely but lonely tropical islands they possess a fierce and unwavering devotion. In the age of sail their location was central and strategic, but in the age of diesel motorships and air travel they are by-passed and forgotten, cultural anachronism created by historical accident and preserved through isolation and the persistence of the human spirit.

## Closing Commentary

It is in such out-of-the-way corners of the earth that some of the richest nuggets await the cultural geographer. We geographers may have a tendency towards preoccupation with our own familiar culture, landscape, and the urgent problems of the moment. There is an antidote for this, I think, in the tropics, in the arctic, in every foreign land and unfamiliar landscape for those who, to borrow a phrase from John Leighly, would look at the land, the sea and the sky with questioning eyes seeking understanding. It is, I submit, worthwhile and revealing to get off the beaten track, seek out the forgotten, inaccessible peoples and cultures. If one is concerned with perspective in the understanding of cultural processes, and with historical geography, the value of such experience can hardly be exaggerated. And, perhaps most important of all, it is often an exciting adventure, both physically and intellectually, of the very sort that originally endeared geography to so many of us . . . but which somehow in the course of years, we have failed to take advantage of as we had originally intended.

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# TYPES OF PEDIMENTS IN THE SAN PEDRO VALLEY REGION, ARIZONA

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The word pediment, as first defined by McGee (1) and as used in this paper, refers to an exposed bedrock surface at the foot of the mountain front, or a rock surface covered by a layer of alluvium no thicker than the depth of the stream scour. In igneous rocks of coarse texture, the pediment may be covered only by its own regolith — i.e, the material weathered in place rather than transported alluvium. Under this definition, which excludes all postulates of an extension of the surface beneath the alluvium, the pediment is only a fragmental feature of the arid landscape in the American Southwest in contrast to the ubiquity of alluvial fans, bahadas, and bevelled piedmont surfaces or "peripediments".

There are at least two major types of pediments in the San Pedro Valley region of Arizona: 1. The narrow rock benches or embayments which fringe a broad mountain mass, and are separated from the alluvial deposits of the basin by a high-angle fault; 2. The extensively bevelled bedrock surfaces out of which the mountains appear to rise as mere residuals. The Santa Catalina and Huachuca pediments belong to the first type, whereas the south Dragoon and Johnny Lyon Hills pediment belong to the second.

### The Santa Catalina Pediments

The northwest and south fronts of the Santa Catalina Mountains show narrow pediments because they have had little time to develop since the latest major uplift along the normal faults in late Tertiary or early Quaternary time (?). The morphology of these pediments can be described best in the context of their adjoining mountain fronts. (Figure 1) The south front of the Santa Catalina Mountains is composed of gneiss. It is much ravaged by erosion, and has a series of parallel canyons separated by bare, sharp-crested ridges. The northwest front is divisible into two morphologic units along the Romero and Montrose canyons. The belt occupied by these canyons marks the transitional zone between gneiss of the southern forerange and an intrusive igneous rock of distinctly granitic texture in the northern portion of the northwest front, where it is known as the Samaniego Ridge. Canyons and sharp crests are absent in the Samaniego Ridge which is rounded at the top and has long, smooth, concave slopes leading down to the foot of the mountain. It is along this granite ridge that amphitheatre-like, incipient pediments have formed. (2)

Wide pediments generally do not occur along a deeply dissected mountain front, and the southern forerange off the Santa Catalina Mountains is no exception. Here, large alluvial fans appear to emerge directly from the mouths

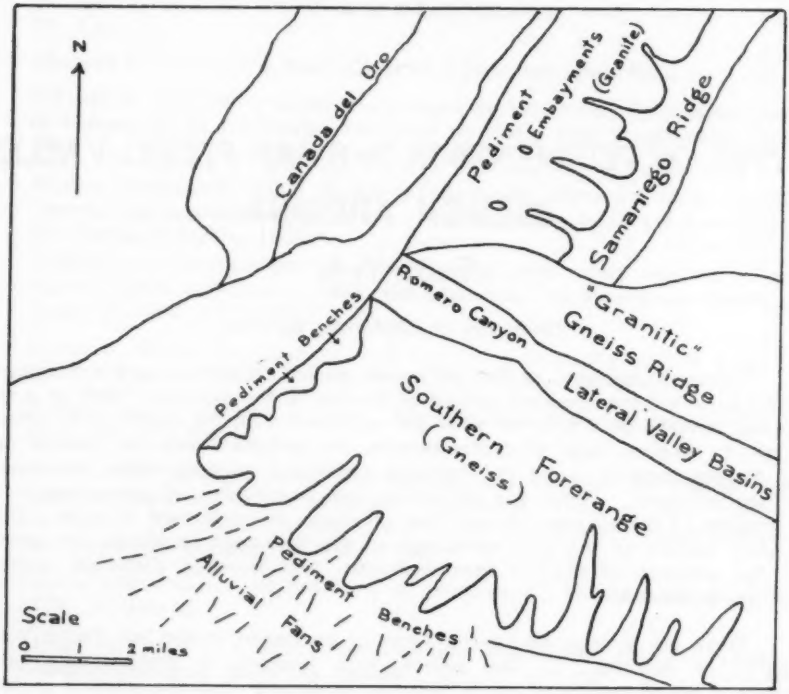


Figure 1. Diagram of the northwest corner of the Santa Catalina mountains.

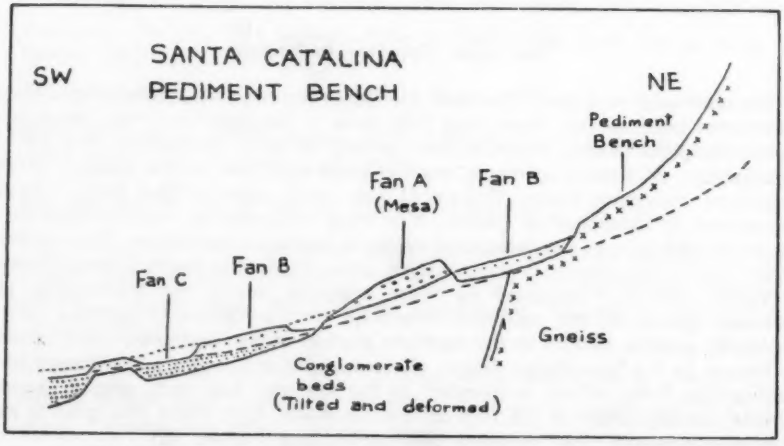


Figure 2. Diagrammatic cross-section of the south front of the Santa Catalina mountains showing the relationship between the pediment benches and the alluvial fans. (Modified from Blissenbach)

of the canyons, and the steep mountain wall seems to be in sharp contact with the aggradational slope of the fans. But this simple arrangement is deceptive and fades upon closer scrutiny. The fans have been much eroded. Blissenbach recognizes three fan levels, the highest and oldest remnants of which are isolated knolls or mesas. (3) The highest fan mesa, when projected toward the mountain front and across the fault that separates the gneiss from the alluvium, correspond in elevation to the narrow pediment benches developed on gneiss, whereas a more recent fan (fan B) still covers much of the lower gneissic surface. It is outside the scope and purpose of this paper to trace the history of the uplift of the mountain front along the fault, and the relation of the succesive fans to the pediment benches. Figure 2 summarizes a possible interpretation in diagrammatic form.

The rock benches are at most only a few hundred feet wide. They have suffered much from erosion, and are best preserved in the intercanyon areas. At the mouth of the canyon, they may rise above the alluvium (fan B) as knolls. The surface of the bench is very rugged. The detached boulders of gneiss do not undergo spheroidal weathering, but retain sharp angles as they break down into smaller sizes. Bare rock with freshly scrubbed appearance outcrops every where. The crevices between the outcrops and boulders collect coarse feldspathic sand washed down from the rocks. Rill wash is the dominant means of transportation and degradation on the rock benches. During each heavy rain, water rushes down the innumerable crevices and channels, and carries away much of the detritus that has accumulated there.

These gneissic rock benches are diminutive as compared with the pediments formed on the granite of the northwest mountain front north of the Romero Canyon. The pediments here are over two miles wide and illustrate to a remarkable degree the effects of the degradation of a mountain front by forces other than dominant vertical erosion by streams along well defined lines as is the case for the southern forerange. In longitudinal cross-section, the pediment is concave. Its gradient changes without break from 10° to 30° below the crest of the Samaniego Ridge. In plan, the pediments are roughly horse-shoe shaped embayments although the open end is obscured by many residuals that rise as knolls about 100 feet above the general level of the rugged surface. The pediments are separated by narrow ridges—almost bare and rounded at the crest. These ridges are being denuded rapidly from both sides and at their tapering ends the pediments coalesce into one surface. The upper parts of the pediments display huge outcrops of bedrock that show a wide jointing system. This lithologic characteristic may explain in part the rounded, concave profile of the pediment, and the absence of any angular break of slope, as sharp changes of gradient are common only with the weathering of closely-jointed granitic rocks. But the lower portions of the pediments have been weathered into a landscape of huge, detached boulders, up to 10 feet and over in diameter. The boundary between the granite and the alluvium is marked by a fault which can be traced for a considerable distance along the northwest front of the Santa Catalina Mountains.

### The Huachuca Pediment

Another example of a narrow pediment developed since the recent faulting movement that determined the present position of the mountain front is to be seen at the Huachuca Mountains. These mountains are bounded by a normal fault—called the Basin-Range fault by Alexis (4) who studied the geology

of the area—and this fault separates the granite from the old alluvium of the basins (Figure 3). It is only exposed where dissection has stripped off the recent alluvium from the narrow pediment. It is hidden for the greater part of the eastern front of the mountains where the streams that drain into the upper San Pedro River have a gentler gradient and therefore less power to erode and transport than those that drain into the Babocomari River at the north front.

The pediment is formed on granite. It is only a few hundred feet wide along the north flank of the Huachuca Mountains. It is exposed wherever stream dissection is sufficient to produce enough local relief for the alluvium washed down from the mountain flanks to be carried away. The profile from the mountain front to the pediment is notably concave and there is again no angular break between them. Compared with the Santa Catalinas, the smooth, sweeping curves of the mountain flanks in the northern part of the Huachucas give the landscape a calmer type of beauty (figure 4). Although bare rock is revealed along almost all the stream channels on the pediment, and is nowhere deeply buried by regolith even on the divides, loose boulders of granite are rare, and the detailed relief has none of the ruggedness of the narrow Santa Catalina benches. It shows a gently rolling topography of rounded mounds with convex profiles. This convexity is caused by rapid stream incision and is limited to the minor features of relief on the pediment. The mountain flanks themselves are concave, which seems to indicate that tectonic movements, in spite of their recency and magnitude, have little or no effect on the present surface forms, or on the degradational forces that produced such forms.

### The South Dragoon Pediment

The broad rock surface at the foot of the south Dragoons is in sharp contrast with the narrow pediments that front the Santa Catalina and Huachuca mountains. The south Dragoons are residuals on an extensive pediment whereas the Huachucas and the Santa Catalinas are broad ranges bordered by an irregular frill of planed rocks.

From the south Dragoon Mountains the pediment slopes outward at a gradient of 50 to 100 feet per mile to the Sulphur Spring Valley. The boundary of the pediment with the alluvium in the valley is very irregular and often hard to determine. Tongues of recent outwash material may protrude into the pediment for considerable distances along the stream courses. The surface of the pediment is smooth, though not flat. There is sufficient incision by the sparsely distributed streams to produce a relief of low divides, subtly convex. The divides are covered by regolith to a depth of not more than one foot. Fresh exposures of bedrock granite are seldom seen on the divides though they may be displayed prominently along the stream channels. Criteria for establishing the surface as a pediment include such occurrences of bedrock outcrops as well as the fact that the cover of regolith on the divides is usually not transported alluvium, but developed through local weathering. The transition from the regolithic cover to the bedrock is a very gradual one—passing through the intermediate stage of much weathered fragments. Near the stream channel, the regolith thins, and in many cases has been found to be in sharp contact with the underlying rock. It represents the material that is being washed down from the broad divides, and will eventually be carried away by the streams in flood to the outer boundaries of the pediment.

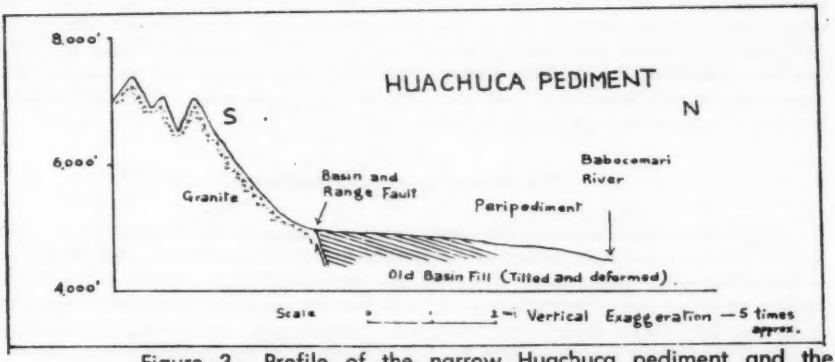


Figure 3. Profile of the narrow Huachuca pediment and the broad peripediment drawn approximately at right angles to the north front of the Huachuca mountains.

Figure 4. The Huachuca pediment and mountain front looking southward from close to the Basin Range fault.

Some knolls, with fresh or barely weathered exposures of bedrock, rise above the general level of the divides. These are commonly found to be later intrusives into the granitic rocks—veins of felsite or bosses of quartz monzonite porphyry. Residuals composed of intrusive igneous rock similar to the pediment are remarkably rare. With the exception of the south Dragoon Mountains, the only other granitic residual lies at the western edge of the pediment. The south Dragoon Mountains are distinguished from the other residual knolls by their greater elevation, the summit being over 1,000 feet above the pediment. The slopes are mostly bare rock, and give the illusion of steepness from a distance, but have in fact only an angle of about 30°.

### The Johnny Lyon Hills Pediment

The Galiuro Mountain range sends out two prongs at the southern end—one is the Johnny Lyon Hills which extends into the Little Dragoons, and the other is the Winchester Mountains. The two are separated by a deeply fliled basin known as Allen Flat. The drainage of both the Johnny Lyon Hills and Allen Flat is to the San Pedro River. The Winchester Mountains are served by shallow channels that blend eastward into the flat monotony of the Willcox Playa. Johnny Lyon Hills consist largely of coarse-texture granite whereas the Winchester Mountains form a continuation of the Tertiary volcanics that make up the body of the Galiuro Mountain range.

The northern part of the Johnny Lyon Hills has been weathered into a narrow, low ridge. Alluvium extends to the foot of this ridge on the east side, but on the west it gives place to a granite surface or pediment almost two miles from the ridge. (5) The pediment is dissected by the shallow washes into low divides with a relief of about 10 to 20 feet (figure 6). It is faintly concave in profile up to the point where it dips under the alluvial apron. This alluvial apron has a steeper gradient than the pediment, so that if the granite surface extends beneath the alluvium, as is very probable, it would have a distinct break of slope (figure 5). The profile of the exposed part of this granite surface or pediment seems to have been graded or regraded with the edge of the alluvial apron as its local base level.

### The Formation of Pediments

This study brings out the great diversity in the form and size of the pediments as well as the irregular pattern of their distribution. It is clearly not yet possible to give any adequate explanation of the formation of these pediments until they can be examined and mapped with care over a much larger territory than the southeastern corner of Arizona. Perhaps the most satisfactory general hypothesis is still Lawson's (6) famous analysis of slope retreat and the evolution of a convex suballuvial bench under conditions of rising base level in a basin of internal drainage. In this analysis, the subaerial bench or pediment appears only in the late stages in the recession of the mountain front, when the surface of the alluvium in the basin is asymptotic to the convex profile of the suballuvial bench. (7) This means that the exposed concave pediment formed with reference to the stable level of the alluvial fill can only be a narrow fringe around the mountain residuals. But in the San Pedro Valley region, some of the pediments are much wider than may be expected from Lawson's analysis. The area of the south Dragoon pediment is over 10 sq. miles, and the pediment west of the Johnny Lyon Hills is nearly 2 miles wide. This may mean either that alluviation and a rising base level was followed by a condition of stable or lowering base

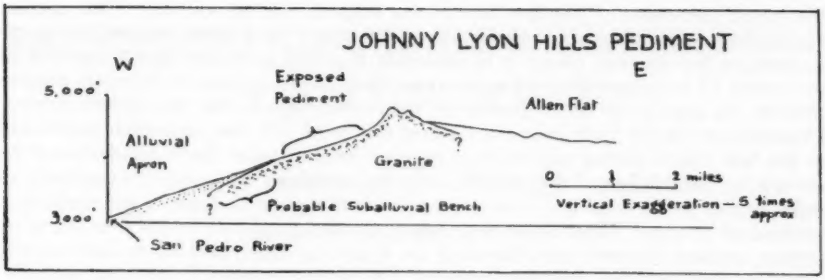


Figure 5. Profile of the Johnny Lyon Hills pediment from Allen Flat in the east to the San Pedro River in the west.

Figure 6. The Johnny Lyon Hills pediment, looking eastward to the mountain residuals in the background.

level in an early stage of the retreat of the mountain front so that the broad pediments have never been covered by alluvium, or that the alluvium once extended farther up the pediment and that its present size is the result of later stripping.

If the first supposition were true, then during the later stages in the retreat of the mountain front, a considerable load of material had to be carried across the broad pediment of low gradient to the edge of the alluvial fill. If the second supposition were true, some agent or agents must have been powerful enough to remove the alluvial cover. It is probable that the principal agent capable of this work of transportation plus the regrading of the pediment through erosion and by the imposition of its profile on the rocksurface is the intermittent stream. Observations in the field seem to support this view. All the pediments examined in the San Pedro Valley region display considerable relief. Such relief cannot be carved by sheetfloods if the sheetfloods are conceived as working essentially at right angles to the mountain front, i. e., down the general slope of the pediment, instead of as sheet flows down the convex divides produced in the first place by stream erosion. Violent sheetfloods of the type first described by McGee usually occur on flat surfaces, and flat surfaces are almost invariably alluvial surfaces. Evidences from the study of the San Pedro Valley region suggest that dissection by streams is an integral part of the complex processes of degradation that produce an exposed or thinly veiled bedrock surface or pediment.

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# THE EVOLUTION OF UNDERSTANDING AN ENVIRONMENT: CLIMATE AND WHEAT CULTURE IN THE COLUMBIA PLATEAU*

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> The interior wheat lands of Oregon and Washington Territory have attracted attention by their unfailing crops, the large average yield, the comparatively small amount of precipitation, and the general dryness of the summer months.
>
> The latter feature has gained for these districts the erroneous name of the rainless regions of Oregon and Washington.(1)

These opening sentences of a government report on the Columbia Basin wheat country published in 1888 may well strike the modern reader with surprise. The widespread reputation of this area as a highly productive grain region has become so firmly established as to invite assumption that the particular climatic conditions prevailing must be very nearly ideal for wheat. Obviously such was not the common opinion at the time of the report quoted. That it was not is worthy of investigation, for it focuses attention upon an important phase in the history of man's contact with this land and, in addition, illustrates an aspect of historical geography which deserves careful consideration.

Contextual reconstruction can only be meaningful within the framework of settlement history. For half a century this entire grassland "Interior" of the old Oregon Country had been dismissed by most observers as unsuited to any extensive agricultural development. Several features of the area contributed to this pessimistic evaluation. Foremost among these was the long summer dry season. Most of the explorers, trappers, traders, and Willamette-bound emigrants passed through the region during the height of this season when the cycle of nature had changed the clear streams and green hills into a dry, dusty, and barren landscape. Journal entries of sufferings from heat and thirst give ample reason for those who labeled it the "Great Columbia Desert." (2) For the most part, the missionaries and others who lived in the area over a period of years were no less discouraging in their opinions. It was generally agreed that the summer drought would always necessitate irrigation to insure harvests and that the hilly topography would thereby severely limit the area of potential settlement.

*A portion of the research for this study was made possible by a grant from The American Philosophical Society. The writer also wishes to acknowledge the cooperation of the Northern Pacific Railway Company for enabling his research in their archives.

## Settlement and Initial Cultivation

The first permanent colonists were the cattlemen who came in at the conclusion of the Indian wars in 1858, attracted by the rolling bunch-grass hills and the rapidly expanding mining markets in the peripheral mountain districts. Agricultural trials began concurrently in the Walla Walla Valley, first in irrigated gardens and small fields, and gradually being extended into the moist "bottom-lands." It was not until the middle 1860's that the success of crop trials on the hill lands enormously enlarged the agricultural potential of the Interior. The influx of settlers was thereby accelerated, although scepticism over the productivity of the hills remained an important deterrant for many years. (3)

As agriculture became firmly established in the Walla Walla and Palouse, interest in the nature of the environment shifted its focus. Whereas in the initial experimental period the question of supreme importance had been whether crops could be raised at all without irrigation, now the problem, less crucial but no less puzzling, centered upon how it was possible for crops to flourish as they did under this peculiar condition of little summer rain.

Although the Columbia Basin was but one of three major regions where agriculture was being developed in a summer-dry climate, it was differentiated in important ways. The growth of crops in the Willamette had never excited comparable surprise. There the dry period was shorter and less severe; not only did it receive a somewhat greater warm season rain, but it had markedly cooler summer temperatures. Indeed, the main "peculiarity" of the region west of the Cascades was the heavy winter precipitation rather than paucity of rain. On the other hand, the summer drought of California was considerably more intense, but winter temperatures were so moderate as to allow the shift of many farming activities to that season, making direct use of winter moisture. Whereas in California late fall or early winter ploughing and sowing of grain was the common practice, during the first two decades of Columbia Basin agriculture late spring sowing was the general rule. Thus the distinctive and puzzling feature was the excellent yield of **spring-sown** crops in a **summer-dry** climate.

## Early Climatic Explanations

Judging from the literature of that day this unusual phenomenon was a topic of considerable interest. The writers of settlement promotion literature were particularly concerned for they were plagued with the apparent contradiction between their impressive statistics on wheat yields and their descriptions of the extreme dryness of the summer season. It was common to cite examples of successful spring wheat crops which had never received the benefit of a drop of rain during their growth, undoubtedly somewhat of an exaggeration but nevertheless a correct emphasis upon the most distinctive climatic feature of interest. That this seemed an improbable combination of facts to the general public unacquainted with the region is suggested by the great lengths to which the promoters went in order to explain just how wheat could thrive in such an environment.

In a lecture on the climates of the Pacific Northwest, Selucius Garfielde, Congressional Delegate from Washington Territory, observed that despite a dry season of at least five months only gardens needed to be irrigated as "spring showers mature most of the crops." However, he went on to state that "it is

probable that tree-planting may increase the amount of summer precipitation along the northerly portion of this vast interior region as far south as lat. 45 degrees." (4) The contemporary literature suggests that this question of the influence of forests and or cultivation on climate was a national topic: in the West it was widely held that the planting of trees and the advance of agriculture had increased, or would eventually increase, the precipitation, whereas in the East drier-than-average years were blamed on the extensive destruction of the forests. (5) Local evidence of this theory is abundant. Characterizing an unusually heavy Agust shower of 1875 as "an old fashioned States rain," a meaningful description to the local emigrant-farmers, a Walla Walla newspaper stated:

> That memorable personage, 'the oldest inhabitant' says that he has never seen so heavy a rainfall, in the same length of time, as has fallen in the last two weeks and during the month of August. The seasons seem to be undergoing a change yearly, as respects the rainfall . . . Some persons, philosophizing upon the subject, attribute the change to the breaking up and cultivation of so much of the soil. That has a tendency to attract the clouds; and that the planting of fruit and ornamental trees contribute likewise to produce the same result. (6)

Such theories received their greatest elaboration in the advertsing booklets issued by regional promoters and agencies. The author of one pamphlet, noting that "some persons have tried to explain the growth of grain on the upper plains by a sort of capillary attraction, drawing up the moisture," and that "it has also been explained by electrical changes, caused by the telegraph," dismissed these ideas and set forth his own in considerable detail. (7) It was his view that:

> the invisible ocean of vapor, constantly borne inland from the Pacific over these high plains, can be cooled and deposited in the form of dews, mists and showers, so as to furnish all needed irrigation . .
> . . The plow proves to be the cooler. It opens the light, porous soil to the air, which enters it freely, and parts with its moisture to nourish the plants . . . Orchards, groves and fields increase the cooling surfaces, giving more moisture and more summer showers in all that region. (7)

Fallowing should be discouraged as the cultivated field "will increase the deposit of moisture and thus assure the coolness and crops on other fields." The remarkable success of crops on the hills was also easily explained:

> the higher the hill, the quicker the cooling process occurs in the still air, so that the night dews and mists water the plant there best every evening when the wind dies away . . . Those high praries that now seem so dry in summer need to be broken up, sown, set with shrubs and trees.

The proponent of these ideas was a prominent publicist of the Northwest and his views were extensively quoted in other descriptive literature of the period. (8)

While many persons were advocating the planting of trees and crops to insure an **increase** in precipitation, others held that the nightly dew was as effective as a "copious shower" and was sufficient. Thus another writer, who recognized that wheat farming in summer-dry climate was "so at variance with common experience that it might well be questioned," held to this dew theory and pointed out that:

> In spite of the fact that there is scarely a shower between May and the

> following October, and that the average rainfall for the year does not exceed 20 inches, there is always the requisite moisture for maturing the crops . . . Paradoxical as it may seem, if the rain were greatly in excess of this low average, damage would certainly ensue . . A summer drought, therefore, which in most climates is a calamity, is here a benefit. The soil needs no more rains after those of the spring are over, and the farmer may depend upon cloudless skies at harvest time. (9)

The success of crops, and faith in such theories, led in some instances to radical re-evaluation of the entire interior country. In 1879 the Surveyor General of Washington Territory, upon the assumption that "as cultivation increases moisture will correspondingly increase," stated that he now felt "warranted in making the assertion **that there is no desert land in this Territory.**" (10) He likewise lamented the neglect of the settlers in taking advantage of the Timber Culture Act, for:

> the value of the timber for wood alone should not be the first consideration in encouraging the growth of timber in a treeless country. The wonderful atmospheric changes, . . . more abundant rainfall being the most important of these, is of much greater importance to the settler. (11)

Whether the climate was actually being changed or whether merely a different moisture relationship was established by cultivation, the fact remained that magnificient grain crops were being harvested from the parched bunchgrass hills which had appeared so discouragingly dry. It seemed obvious in some ways an increase in moisture had been induced by cultivation and settlement. The concurrent advance of the farming frontier into the drier sections of the Great Plains was prompting even greater theorizing and agitation. There were, of course, critical differences in the agro-climatic relationships of the two regions. However, the general problem was similar and presumed evidences of the influence of settlement and cultivation upon rainfall in Kansas and Nebraska were often used in support of the applicability of this theory to the Columbia Basin. (12) As a compiler of a government report on the West concluded: "the question of increasing the amount of rainfall throughout the extensive dry interior of the country is one of the most important problems of the age." He went on to mention the various current opinions as to how this might be accomplished; these included tree planting, construction of railroads and telegraphs, and the extension of irrigation to increase atmospheric moisture. (13) Thus the literature of the day suggests that not only was "everybody talking about the weather." a great many were proposing that something could be done about it.

### The Growth of Understanding the Environment

At the same time, however, others were thinking along different lines. The extraordinary results of wheat raising in the Pacific Coast states had caused a great deal of comment. In an 1880 government report attention was called to the fact that wheat was actually **best** suited to a summer-dry climate:

> The ideal climate for wheat is one with a long and rather wet winter, with but little or no frost, prolonged into a cool and rather wet spring, which gradually fades into a warmer summer, the weather growing gradually drier as it grows warmer, with only comparatively light rains after the blossoming of the crop, just enough to bring the grain to maturity, with abundant sunshine and rather dry air toward the harvest, but without dry and scorching winds until the grain is fully ripe, and then hot, dry, rainless weather until the harvest is gathered. (14)

Such an opinion was contrary to the centuries-long heritage of American farmers and was a marked change from most of the earlier scientific reports. (15) Though this description was based upon Californian conditions and therefore did not fully explain the particular Columbia Basin situation, it did represent a significant change in view relevant to the problem.

Interest in the existent agricultural conditions as well as in the potentiality of the large areas as yet unsettled, prompted several detailed studies to be made. The first careful scientific investigation of the region was undertaken by the members of the Northern Transcontinental Survey, which was organized by the Northern Pacific Railroad. (16) Professor E. W. Hilgard was placed in charge of the soils investigations. While making a midsummer reconnaissance of the Big Bend country, Hilgard was struck by the appearance of scattered clumps of giant ryegrass on the highest hills, a plant which had heretofore been found only in the valleys of the Yakima country and had been thought to be an indicator of alkali soils. Closer examination revealed an important feature:

> . . . these tufts of grass are always located on ground either heretofore or at present occupied by colonies of badgers, which have given the ground a most thorough subsoiling and tilth. In other words, it shows that the rye-grass follows **not** the alkali, but **moisture**; and its existence here points the way clearly for the operations of the farmer. Cereal crops will grow wherever rye-grass will, provided the tillage be as deep and as through as in these badger colonies, where moisture can always be found at ten to twelve inches in depth. (17)

This view implied, of course, that success in the more humid areas already under cultivation was in part caused by the high moisture retentiveness of the soils. In a sense, then, an "increase in moisture" did indeed "follow cultivation," not in the form of rainfall or dew, but in making use through proper tillage of that which was already stored in the soil: a subsurface rather than an atmospheric change.

The widespread interest in the circumstances of wheat raising in the Pacific Northwest culminated in the ordering of a government investigation to ascertain the basis of crop success under the unusual conditions. The survey was carried out in 1885 by Lieutenant Frank Greene of the Signal Corps and the results published in 1888. (18) It was in the introductory paragraph of Green's report that reference was made to the erroneous conception of the "rainless regions of Oregon and Washington."

One of the main features of Greene's investigations was the extensive use of a questionnaire to gather the opinions of wheat farmers on the question of "popular opinion as to why wheat can be successfully grown under these conditions." (19) The answers are remarkable in the extent to which they emphasized the high moisture-retentiveness of the soil as the major factor. A few suggested heavy dews as the most important cause. On the basis of his own examinations, however, Greene concluded that in general, quite the contrary, there was a "marked absence of palpable dew in the spring and summer months." (20) He concluded that crop success could only be explained by taking into account several interacting factors which together formed a peculiar environmental complex:

1. a soil of great fertility.
2. a friable soil which readily absorbs moisture.

3. an underlying stratum of clayey hardpan which arrests percolation within reach of the plant roots.
4. generally mild winters, with a snow cover which usually melts gradually.
5. a rainfall of low intensity, with a moderate amount during the early growth of the wheat.
6. thus nearly all the moisture is absorbed and retained for plant use.
7. a nearly dry ripening and harvest season, but rarely with severe desiccating winds.
8. perhaps to a slight extent, a latitudinal advantage which gives longer hours of sunlight during the maturing season. (21)

Here was the most comprehensive explanation to that time, one which went beyond any simple theory and involved a consideration of precipitation quantity, type, distribution, and intensity; humidity; winds; and soil texture, horizon, and fertility. Within such a context the climatic conditions could now be regarded as definitely favorable rather than "peculiar" and perhaps unreliable. It should be noted that by the time of Greene's investigations most of the wheat farmers had shifted from spring to winter wheat and this undoubtedly made crop success under these environmental conditions more readily understandable. Nevertheless, spring sowing was still not uncommon, particularly when the winter wheat had been damaged by frost, and the emphasis upon the particular climatic soils conditions provided a rational explanation for crop success in the past as well as at the time of this report. Although subsequent studies have refined understanding and modified certain aspects and emphases, the Greene Report stands as a major contribution in the evolution of environmental understanding of the Columbia Basin wheat lands. (22)

In this same year, 1888, the first analytical climatic reports on the region were published. These studies, made under the direction of General A. W. Greeley, Chief signal Officer, were designed in part to provide reliable information for prospective settlers. (23) The representation that "the interior portions of Oregon and Washington were almost rainless," was specifically mentioned as one of several erroneous common opinons needing correction. (24) The residents of the region were of course aware of this fallacy, however the data also suggested that both the length and severity of the dry season were somewhat less than locally believed. The idea of an actual rainless season from May to October found no verification in the climatic records accumulated during the previous years. (25)

As to whether the climate had actually changed anywhere in the West as a consequence of settlement and cultivation, the reports were inconclusive, although acknowledging that some increase in precipitation might have been effected.(26) The farmers' emphasis upon the importance of soil moisture in answer to Greene's questionnaire suggests that theories based upon atmospheric change had been largely replaced in the older sections where wheat was well established. However, on the margin of the advancing frontier the old ideas continued in force. The success of wheat in the drier western sections of the Palouse and Big Bend was amazing even to the local residents; the only logical explanation seemed to be an increased rainfall in consequence of settlement. (27)

As climatic data accumulated the experts began to take a stronger stand, concluding that forests and cultivation had no appreciable effect, and that while climate exhibited irregular oscillations it was not changing. (28) Likewise, soil scientists and agronomists gradually built an ever more detailed understanding of the environmental complex. But as scientific knowledge deepened, popular interest waned. Although presumably a keener colloquial understanding became more widespread with the passing years, it would be unwise to infer that interest declined because the scientific had gained full ascendency over local ideas. Rather, a new stage in regional life had been reached. By World

War 1 settlement in the Columbia Basin had become essentially stablized. The great "boom" period was over and no longer was it important to explain to others the basis of wheat culture, so that the volume of regional descriptive literature drastically declined. (29) And as social horizons broadened, the local newspaper was transformed into an adjunct of the national press; the routine of farm life was no longer newsworthy, the cycle of the seasons, the condition of the crops, the ways of doing things became dully commonplace. If this reflected the general cultural growth of the nation, it was equally evidence of regional maturity. (30) The ever-lengthening history of crop success, the ever-widening frame of the Walla Walla, Palouse, and Big Bend as excellent wheat lands made it easy to simply take for granted that this particular environment must be nearly ideal. The paradoxical, anomalous, "peculiar" conditions of earlier years had become perfectly matter-of-fact and familiar.

## Conclusion

Proper refinement of our own understanding of the past requires us to know more about this evolution of understanding with regard not only to climate but to all significant aspects of the environment within each of the broad regional divisions of American agriculture. Just what were the nature and the basis of such opinions? (31) How widely were they held? To what extent were ideas formulated in one region transferred to others, and what were the consequences of such heritages? Does this evolution of ideas proceed through a common series of stages from region to region? (32) We can never fully comprehend the problems of colonization and development until we know the answers to these and similar questions. Moreover, no phase of the geographer's study of the past has greater relevance for the present. Dr. George Carter's pregant observation that "the world's agriculture is largely historical and nonrational" ought to be ever before us. (33) Reconstruction of the climates of opinion and the reconstruction of the material features and functional patterns of the past are interdependent and must proceed together in the mature pursuit of historical geography.

## Notes and Literature Cited

1. Frank Greene, **Report on the Interior Wheat Lands of Oregon and Washington Territory,** Senate Exec. Doc. 229, 50th Congress, 1st Session, 1888.

2. This regional name was first employed by Franchere who crossed the area in 1814; Gabriel Franchere, **Narrative of a Voyage to the Northwest Coast of America in the Years 1811, 1812, 1813, and 1814.** (French edition, 1820; English edition, 1854) reprinted, Reuben Gold Thwaites, editor, **Early Western Travels, 1748 - 1846,** Vol. VI, Cleveland, 1904. "Desert" descriptions were common until the 1850's. It is significant that the outstanding early exceptions to this view, those of Lewis and Clark and of Captain Bonneville, were made by men who contacted the region during other seasons. The former passed through in October, 1805, and returned in April - May, 1806; Bonneville skirted the margin of the Walla Walla country in February, 1834.

3. Settlement expansion tenaciously followed the valleys. These provided advantages homesites, with wanter and, in some areas, wood readily available. However, each new area went through the same cycle of crop experimentation with the hill lands before the settlers became convinced of the suitability of such land.

4. Selucius Garfielde, **Climates of the Northwest,** Philadelphia, 1871, pp. 3, 16.

5. Any extensive examination of original sources will reveal expressions of these views. **E. g.** see the following volumes of **Report of the Commissioner of Agriculture:** 1869, p. 516; 1870, p. 508; 1871, pp. 233, 354-5; 1873, p. 384-6.

6. **The Spirit of the West,** (Walla Walla, W.T.), September 3, 1875

7. The following material is based upon G. H. Atkinson, **The Northwest Coast, including Oregon, Washington and Idaho, a series of articles upon the N:P.R.R. in its relation to the Basins of the Columbia and of Pudget's Sound** (Portland, 1878). This pamphlet is a collection of articles originally published in the Portland Oregonian.

8. Atkinson, an avid amateur meteorologist, served for several years as "Chairman of the Committee on Meteorology of the Board of Trade of Portland, Oregon" and lectured and wrote extensively on Northwest weather and climate. See Nancy Bates Atkinson, **Biography of Rev. G. H. Atkinson, D:D.,** Portland, 1893, pp. 132-3, 145-7: His theories are quoted in such publications as **Report of the President and Directors of** pp. 11-12; **Report of the Governor of Washington Territory,** House **the Northern Pacific Railroad Co., Sept. 26th, 1877,** New York, 1877, Doc. 1, Pt. 5, 48th Congress, 2d Session (1884) p: 581; **Eastern Washington and Oregon,** (Farmington, W.T., 1888), pp: 25ff.

9. **The Pacific Northwest,** New York. 1882, pp. 19-20.

10. W. McMicken, "Report of the Surveyor General of Washington Territory," in **Report of the Secretary of the Interior,** House Exec. Doc. 1, Pt. 5, 46th Congress, 2d Session, 1879, pp. 898-9. McMicken had been particularily impresed with a few experiments with cultivation in some of the saagebrush valleys. He cautioned, however, that in these areas wheat ought to be planted in the fall. This opinion was also largely supported by Symons, who made an extensive reconnaissance of the Columbia Basin in 1881; Thomas W. Symons, **The Upper Columbia River and the Great Plain of the Columbia,** Senate Exec. Doc. 186. 47th Congress, 1st Session, 1882, pp. 112-3.

11. W. McMicken, "Report of the Surveyor General of Washington Territorp," in **Report of the Secretary of the Interior,** House Evec. Doc. 1, Pt. 5, 47th Congress, 1st Session, p. 916.
12. **Cf.** Symons, **op. cit., p. 113.**

13. Joseph Nimmo, Jr., "The Range and Ranch Cattle Business of the United States," in **Report on the Internal Commerce of the United States,** May 6. 1885, House Exec. Doc. 7, Pt. 3, 48th Congress, 2d Session, 1885, pp. 104-5.

14. William H. Brewer. "Report of the Cereal Productions of the United States," **Tenth Census of the United States,** 1880, Vol. III, p. 63.

15. Heretofore favored localities in the east central states were generally

used as exemplary of "ideal" wheat climates; cf., Lewis Bollman, "The Wheat Plant," **Report of the Commissioner of Agriculture for the Year 1862,** pp. 67-68. An outstanding exception is the report of Blodgett, a well-known climatologist, in which the wide climatic limits of wheat were emphasized and its adaptability to the climates of the Pacific states was noted; Lorine Blodgett, "Agricultural Climatology of the United States Compared with that of Other Parts of the Globe" **Report of the Commissioner of Patents for the Year 1853, Agriculture,** Exec. Doc. 39, 33rd Congress, 1st Session, 1853, pp. 328-432, esp. 392, 395.

16. As the recipient of a very large land grant the Northern Pacific had an obvious interest in regional development. As the company reported to its stockholders: "The survey will obtain the data necessary to guide the Company in the building of feeders, in deciding questions of policy as to encouraging the starting of different industries. and in directing immigration. It is also intended to furnish the public such information concerning the great North-west as will promote a sound development of the country, and thus increase the prosperity of the companies under whose auspice it is conducted." **Report of the President to the Stockholders at their Annual Meeting, September 21st, 1882,** New York, 1882, p. 38.

17. E. W. Hilgard, "Report of E. W. Hilgard to Professor R. Pumpelly, Director, Berkeley. Calif., June 4, 1883," letter in files of Land Department, Northern Pacific Railway, St. Paul, Minnesota. This particular portion of Hilgard's report is reprinted in **The Northwest,** Vol. 2, no. 4, April, 1884, pp. 1-4.

18. Greene, **op. cit.**

19. **Ibid.**. pp. 18-21.

20. **Ibid.,** p. 11.

21. The above factors are not summarized as such in the report, although most appear in Greene's summary, **ibid**., p. 16.

22. The major modification in interpretation is in the matter of soil structure. Greene's emhasis upon an imperious "hardpan" was incorrect. There is no actual hardpan, the high moisture retentiveness being due to the excellent soil structure (arrangment of soil particles) of the "A" and "B" horizons, both of which are very deep.

23. A. W. Greely, **The Climate of Oregon and Washington Territory,** enate Exec. Doc. 282, and **Rainfall of the Pacific Slope and the Western States and Territories.** Senate Exec. Doc. 91, 50th Congress, 1st Session. 1888.

24. Greely, **The Climate of Oregon and Washington Territory,** p.5.

25. The Walla Walla record covered sixteen years; data for most of the other stations were available for only two to six years.

26. The effect of forests as factors in the increase of rainfall is more or less questioned, but the weight of opinion and of accumulated evidence tends to confirm the theory that forests do slightly increase the rainfall." Greely, **Rainfall of the Pacific Slope and the Western States and Territories,** p. 9.

27. Cf. "New Regions for Farmers," **The Northwest,** Vol. 6, no. 8, August. 1888, p. 2; W. H. Lever, **An Illustrated History of Whitman County** (n.p.,

1901), p. 188. Belief in the influence of forests on climate was far from erased in the older sections. A four-year period of less than average precipitation in the Walla Walla country was believed by many local residents to be the result of the cutting of timber in the adjacent Blue Mountains, **An Illustrated History of Southeastern Washington,** Spokane, 1906, p. 383.

28. **Cf.** Willis L. Moore, "The Influence of Forests on Climate," Report to the Committee on Agriculture, House of Representatives, Washington 1910, pp. 5, 10-15.

29. Although most of the "booster" literature was full of extravagant claims about the productivity and general desirability of the particular region under discussion, it did play an important role in publicizing the results of scientific investigations as the writers were quick to cite any data from authorative sources which dispelled damaging misconceptions and gave support to the agricultural excellence of their locality. Thus, for example, material from the Greely climatic reports of 1888 was quoted in such literature as **The Minneapolis Tribune,** April 4, 1889; **The Northwest,** Vol. 7, no. 5, May, 1889, p. 14; and "The Palouse Country". a Northern Pacific Railroad advertising folder, n. p., **circa** 1890.

30. On the importance of this change to the problems of local history research and to phases in the evolution of environmental knowledge as it applies to the history of agricultural colonization in the central states, see James C. Malin, **Winter Wheat in the Golden Belt of Kansas,** Lawrence. 1934, esp. Chapter 18.

31. While superficially many of the early ideas may appear ridiculous, closer study suggests that most were by no means wholly illogical within their contemporary context of reasoning. Thus the theory that the electrical changes produced by the telegraph caused an increase in precipitation appears likely to have been a somewhat extreme extension of the idea that lightning, being an expenditure of energy and therefore a cooling process, was the cause of the precipitation associated with thundershower. See **Report of the Commissioner of Agriculture,** 1871, pp. 354-5.

32. In general, three broad stages in the evolution of understanding appear to be common: 1. Pre-settlement speculation on agricultural potentiality. 2. The revision of ideas in consequence of actual colonization and the formulation of folk theories to account for the results obtained. 3. Long-term scientific study which confirms, denies, or modifies popular opinions. The interaction of folk and scientific knowledge is a most difficult but important phase worthy of closer examination. There is enough evidence to suggest that the scientist's opinions and recommendations have not always proved superior to local ideas and practices.

33. George F. Carter, "The Role of Plants in Geography" **Geographical Review,** Vol. 36, 1946, p. 128. Carter made this statement in connection with his warning that plants are not always grown in climates best suited to them, nor are the plants found in a region necessarily the most suitable for that region. The warning may be applied in a wider sense to our interpretations of the reasons for particular agricultural complexes, cultivative systems, machinery, and other features of the agricultural scene.

# THE ALASKAN SALMON INDUSTRY—PROLOGUE AND PROSPECT

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Outstanding among the world's sea-food resources which are marketed in processed form is the Alaskan salmon. The Territory's Salmon fishery accounts for two-thirds of the total world production of canned salmon. (1) (In 1952 the Alaskan canned salmon output amounted to $79,237,355.) As the only major "surplus" food-fish area, the salmon industry's role vis-a-vis world-wide sea-food deficit region is patent. The industry is almost entirely dependent on export to the United States and foreign markets. In normal times the products of Alaskan canneries reach Western Europe, Latin America, the Philippines, and the Antipodes. In terms of distance even the "local" markets of the United States are remote.

Prosperity or depression in Alaska depends largely upon its fisheries, in which the salmon play the prominent role. The salmon canning business provides ". . . the greatest field of employment for her citizens, and the chief source of her tax revenue." (2) In 1946 it was estimated that the salmon industry provided at least 60 per cent of the Territory's direct tax revenue. In 1950 data show that the fishery taxes alone, which had been extensively revised upward from those of 1949 by the Territorial Legislature, netted $2,350,842. (3)

## The Present Problem

The present problem of the salmon industry has its roots in its own history. Exploitation has become more technologically efficient and at the same time more intensive. Biological replacement of the salmon stock has deteriorated. It is somewhat controversial as to whether this decline is due to overfishing, or to a natural decline in the population not yet understood by man. Dr. William F. Thompson, Director of the University of Washington Fisheries Research Institute, has stated: " . . . the industry must not make the mistake of trying to remedy by law something that is a natural occurrence." (4) The Fish and Wildlife Service, on the contrary, inclines toward the overfishing viewpoint. Whatever the cause, the decline is undeniable. From a 1936 peak, when about 8,000,000 cases of salmon were produced, the 1953 pack of less than 3,000,000 cases was disastrously low. Under financial strain the problem facing the industry is to restore equilibrium between fishing-cannery capacity and the limited supply of salmon.

There is evidence to support the overfishing theory. During both world wars the pack of the canneries was greatly expanded to meet wartime demands for protein-rich salmon. On each occasion conservation measures ceased and on each occasion the good years were followed by years of scarcity. In 1918

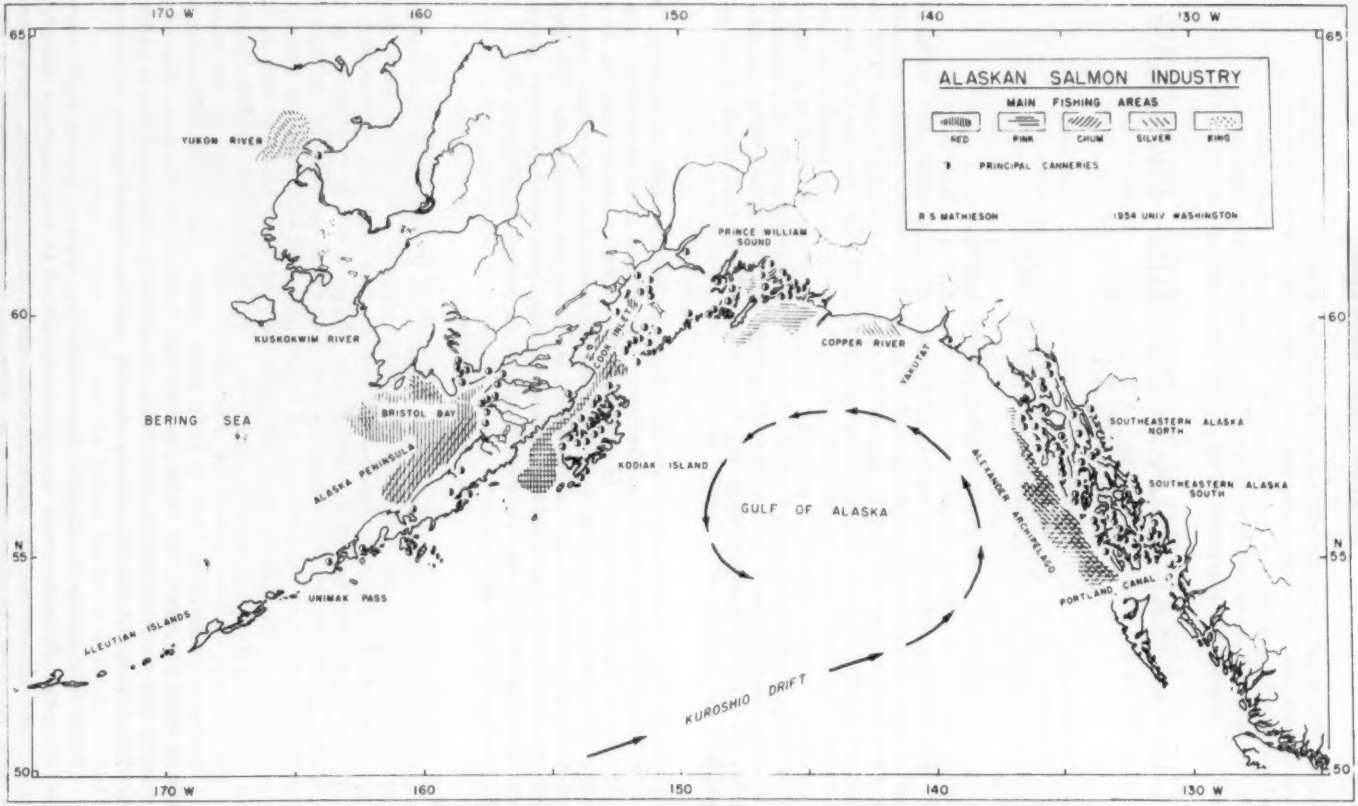


**Figure 1. Chief Fishing Areas Significant to the Alaskan Salmon Industry**

some 135 canneries packed 6.6 million cases, equivalent to more than 100,000,000 salmon of various species. Even with more intensive fishing and immense strides in cannery technology this 1918 pack has been exceeded only six times in the years since.

Beween the wars an uneasy balance existed between cannery capacity and the salmon catch. Production levels fluctuated widely from year to year. Each dip in the level led to fishing in new and remote areas, and to a greater concentration in the cheaper species hitherto little worked. Curtailment of the catch under the powers granted to the Secretary of Commerce in 1924, for the purpose of conservation of Alaskan salmon, was roundly criticised by the industry. Up to the outbreak of World War II resourceful attempts by the Fish and Wildlife Service to rehabilitate the salmon runs had not resolved the damage of earlier exploitation.

During World War II the industry underwent a rapid expansion. A Government-Industry Committee, known as the "Alaskan Salmon Industry Concentration Program", was set up. Its plan, approved by the wartime Coordinator of Fisheries, reduced the number of operating canneries, and to some extent the pack, in the interest of economies in the use of manpower, transportation, fishing vessels, and supplies needed to strengthen the war effort. In this scheme only the most efficient and well-located canneries were operated. The result of this concentration was more intensive fishing, inadequate regulation, and poor escapement of fish under the stimulus of scarcity demand. As a result of wartime exploitation a vicious downward spiral in the salmon industry has become apparent in the postwar period.

In 1954 the difficulties have come to such a pass that the **Pacific Fisherman,** the principal professional organ of the industry, comments as follows: " . . . the adverse Alaska salmon run in 1953 carried the canned salmon pack of the Territory below 3,000,000 cases for the first time since 1921, and brought the industry and the Federal authorities face-to-face with a situation demanding courageous administrative action and industrial sacrifice to the end that the salmon resource might be restored." (5)

### Geographical Milieu of the Salmon Fisheries

The North Pacific Ocean is the principal habitat of the salmon. Although its latitudinal range is considerable — from 37°N. to perhaps 70°N., the Pacific salmon is found in its most prolific concentration between latitudes 45° and 60°N. Thus the continental margins of North America and Asia from the Columbia River westward to the Kurile Islands, Sakhalin, and the Amur Estuary are all well within the North Pacific salmon belt. Depletion of the Columbia River runs took fishermen northward into Alaskan waters in the eastern Pacific, and in the western Pacific the Japanese fishermen also shifted northward, following the depletion of the more southerly runs.

Along with oceanic conditions as a factor in the abundance of salmon should be reckoned the favorable coastal conditions of Alaska. More than 3,000 islands and an intricate coastline 33,000 miles in length provide numerous short streams falling directly to the sea. As an anadromous fish the Pacific salmon invariably returns to its natal stream on maturity to spawn but once and then die. The fiord and skerry coastline abounds in short, glacier-fed streams and longer "hinterland" rivers in which aggradation deposits form suitable spawning-beds for salmon. The straits, bays and numerous inlets form excellent feeding grounds

for the salmon en route to the streams. This geographic condition canalizes the runs to render commercial exploitation easy. Nevertheless the runs remain only for a short while within economic striking distance of commercial fishing gear. Most salmon are taken in prime condition near the river mouths just at the time they cease to fed and before they begin their ascent of the spawning streams.

The Alaskan salmon fisheries are distributed between three major regions comprising a total of ten districts ranging from the Yukon River southeastward to Portland Canal (Table 1; Fig. 1). Each of the districts has distinguishing characteristics in respect of species taken, fishing conditions and cannery operations. (6) The major regions are:

1. Western region, comprising the Yukon and Kuskokwim Rivers; Bristol Bay; the northern coast of the Alaskan Peninsula; and the Aleutian Islands westward from Unimak Pass.

2. Central region, comprising the southern coast of the Alaskan Peninsula eastward from Unimak Pass, and including Cook Inlet, Prince William Sound and the coast west of Yakutat Bay.

3. Southeastern region, embracing all the coastal waters of the southeastern mainland and the Alexander Archipelago southward from Yakutat Bay to the Portland Canal.

Table 1

**Alaska Salmon Districts: (7)**

**Percentage of Total U. S. Pack by Species**

| District | Percentage of Total United States' Salmon Pack by Species (1943-48 Av.) | | | | |
|---|---|---|---|---|---|
| | Red | Pink | Chum | Silver | King |
| Yukon River | ..... | ..... | ..... | ..... | 2.2 |
| Bristol Bay | 60.3 | ..... | 5.7 | 0.7 | 3.3 |
| Alaska Peninsula | 9.4 | 6.7 | 13.0 | 3.7 | ..... |
| Kodiak Island | 6.9 | 20.9 | 6.0 | 1.9 | ..... |
| Cook Inlet | 7.9 | 3.0 | 11.5 | 3.4 | 9.9 |
| Prince William Sound | 1.0 | 16.7 | 11.2 | 3.1 | ..... |
| Copper River | 2.8 | ..... | ..... | 11.7 | 1.6 |
| Yakutat | 0.6 | 0.1 | ..... | 3.9 | ..... |
| Southeast (North) | 2.2 | 10.9 | 19.6 | 9.2 | ..... |
| Southeast (South) | 2.5 | 31.7 | 26.4 | 25.3 | ..... |
| Total Alaska | 93.6 | 90.0 | 93.4 | 62.9 | 17.0 |

### Species of Salmon and Their Peculiarities

A brief review of the different species of salmon will shed some light on the varying geographical habitat and economic conditions of exploitation associated with each. The Pacific salmon, of which there are five distinct species, is classified within the genus **Oncorhynchus.** Sometimes the steelhead trout, genus **Salmo,** is incorrectly classed with the salmon by fishermen. As early as 1731 two Russians, Kraschenikov and Steller, almost simultaneously distinguished the species of the Pacific salmon and gave them scientific names from the Russian vernacular. a) In this paper these species are distinguished by their common names in Alaska which, however, are not consistently and universally applied either in the United States or Canada. In order of their commercial importance these species are: 1. Red, 2. Pink, 3. Chum, 4. Silver, and 5. King salmon (Table 1).

**Red Salmon** — Red salmon vary greatly in size in different districts. The life cycle is four or five years, and the four-year abundance cycle gives rise to quadrennial fluctuations in the pack. This species favors streams with accessible lakes in their courses, and may ascend many hundreds of miles to headwater corrie-lakes. (8) Many glacially scoured streams having strings of lakes along their valleys have considerable Red runs. The Red makes its "nest" in the gravels of the streams tributary to the lake. Normally the fingerling will spend some time in the lake before entering the sea.

Western Alaska is the main region for the Red salmon fishery. The highly valuable fishery of the Bristol Bay district has canneries and freezerships operating largely, although not exclusively, on the harvest of Reds. The bulk of the run in this district occurs in early July. The Karluk and Chignik rivers have two Red runs, in June and in August. Central Alaska has minor runs of Reds interspersed with those of the more numerous other species. The Red run in Prince William Sound begins somewhat earlier than the normal mid-June opening of the season. Despite differences in the onset of the run, its duration varies little between districts.

**Pink Salmon** — The Pink Salmon is the smallest of the five species, but ". . . is remarkably uniform in size in any particular locality and season." (9) The Pink is the second most important species. Its life cycle is invariably two years, with alternate years marked by the largest runs. Abundance in normal years and the uniformity condition accounts for the economic importance of the Pink. The whole of the catch is canned.

The Pink spawns not far from the sea, moving upstream only far enough to avoid congestion at the spawning-beds and to be out of reach of tidal influences. The fingerling Pinks move to the sea during their first spring. The effective spawning area is greatly increased, since many short streams which suit the habit of the Pink are not used by other species. The murkier waters of the sediment-bearing streams and estuaries make the Pink pecu-

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a) **Species of Pacific Salmon (alternative names in parenthesis):**
**Oncorhynchus tschawytscha — King (Chinook, Spring, Tyee, Quinnat)**
**O. nerka — Red (Sockeye, Blueback, Sukkegh)**
**O. kisutch — Silver (Coho, Silverside, White)**
**O. keta — Chum (Keta)**
**O. gorbuscha — Pink (Humpback)**

liarly susceptible to gill-net fishing since its entanglement with the net is closely related to impeded vision.

The species ranges from Puget Sound to the Alaskan Peninsula and the Aleutians. Few Pinks are caught on the Bering Sea side, however. Southeastern Alaska, Prince William Sound and the Kodiak district have outstanding runs of Pinks. In most districts the Pink run is of three months' duration, from June through September. Many of the canneries in this region and others situated in Central Alaksa depend mainly on the Pink for their season's pack.

**Chum Salmon** — The Chum salmon is third in commercial importance in terms of both volume and value of pack.

This species spawns even nearer to tidal water than the Pink. The Chum has a four-year life cycle under normal circumstances. The fingerlings, unlike those of the Red and the Pink, enter the sea as soon as free-swimming. Under this circumstance the mortality of the Chum from its natural enemies is very high and special requirements in ecapement are desirable to offset this loss. In most areas the Chum run appear in mid-June although the height of the season does not occur until late Agust and early September.

The Chum has a very wide distribution, ranging from Puget Sound northward to Bristol Bay. As with the Pink, however, the primary catch is taken in Southeastern Alaska. In Central and Western Alaska the abundance of the species is somewhat localized, and it is not much sought after.

**Silver Salmon** — The Silver salmon is little valued for cannery purposes. The Silver does not tarry at the mouth of the spawning streams as do other species of salmon. It is also wary of nets. Moreover, the Silver runs in small numbers from July well into November, the time varying somewhat in various districts. These factors, taken together make the Silver rather unprofitable to fish, especially late in the season when it is running alone. Consequently, comparatively few Silvers are packed by the canneries. Fortunately the Silver, together with the Chum and the King salmon, also finds a ready market as fresh, frozen, or smoked fish. For this market the Silver and the King are often taken early by troll-fishing, before the run season, while the salmon are still actively feeding in the open sea.

The Silver is taken principally in the streams of Southeastern Alaska, although the Copper River district of Central Alaska has a sizeable run.

**King Salmon** — The King salmon is the largest of the Pacific salmon, reaching 70 to 100 lbs. in rare instances. Despite its size, however, the King ranks lowest in the Alaskan salmon pack. The King has a life cycle of four to six years, occasionally seven. Although the flesh of this species may be a deep salmon red, up to one-third of the catch may have white meat, a phenomenon not yet explained scientifically. This renders the King almost worthless in the canning industry in which color-prestige is so highly and irrationally developed. Most King salmon are taken off the Yukon and Kuskokwim Rivers in the Bering Sea and the Copper River district of Central Alaska. The Cook Inlet run is invariably composed of red-fleshed Kings. The Taku and Stikine Rivers of Southeastern Alaska also have small runs of King salmon.

### Production and Distribution

Economic conditions in the salmon industry arise primarily from natural causes. Several factors operate to render it one of the most ruthless gambles in modern commercial enterprise. First, despite growing biological information

there remains a subtantial element of unpredictability in the salmon run. The fisheries experts have accomplished much in investigating routes of migration from the ocean to the natal stream, in actuarial calculations, and in the prediction of the time, duration, and probable numbers of fish in the salmon run. The fresh water history of the various species is fairly well known. Nevertheless, cerain gaps in knowledge persist, and in the final analysis luck play the decisive role in the commercial success of failure of the fishery. The runs of salmon may come in abundantly, sparsely, or not at all; they may come earlier, or later than usual; they may be in prime condition or poor in quality. Risk cannot be caculated accurately under such conditions of uncertainty.

Today, as throughout the history of salmon canning, the small, single canning company remains the viable denominator in the industry. There are just over 100 canneries operated by some 75 companies in Alaska at the present time. In this way the risk is spread. Apart from the uncertainity factor the smallness of the typical cannery is owing to three other factors:

1. The quantity of salmon of various species in any particular cannery area.

2. The effectiveness of competitive fishing which distributes the catch between many canneries on a supply-and-demand basis.

3. The need for immediate processing.

The industry's history is full of boom and bust, short-lived financial success, and bankruptcy for the individual packer. Attempts to create the "big" firm by mergers or outside capital have been largely failures. As time has progressed the industry has become more strongly competitive. This is indicated by the large number of firms, many of which operate on a shoestring basis. Nevertheless four large firms, the Pacific American Fisheries, Libby, McNeill & Libby, the Alaska Packers Association, and the New England Fish Company account for about one-third of the total Alaskan pack and provide a strong price-leadership to the numerous smaller firms. The larger firms are responsible for economies of scale and vertical integration, carrying out fishing, processing, and marketing operations on their own account. The industry maintains a trade association, the Alaska Salmon Industry, Inc., for the purpose of negotiating on labor and other questions.

In its labor patterns the salmon industry is almost unique. The annual labor requirement amounts to about 20,000 in normal years. The employment is highly seasonal in character, and is completely unionized. About 90 per cent of the labor force is recruited in the Seattle area, the balance coming from Portland, and from Alaska. In the postwar years, Filipino workers have been increasing in numbers at the expense of the Chinese and Japanese elements. White labor comprises about 40 to 50 per cent of the cannery labor force.

Since 1946, the larger companies have found it economical to transport labor to and from Alaska by air. In 1953, almost 10,000 workers were so transported. Air transportation is economical since the worker is paid from the date of departure to the date of return. In such circumstances savings in non-effective wages and subsistence allowances incurred during the sea passage more than offset the greater cost of transit by air.

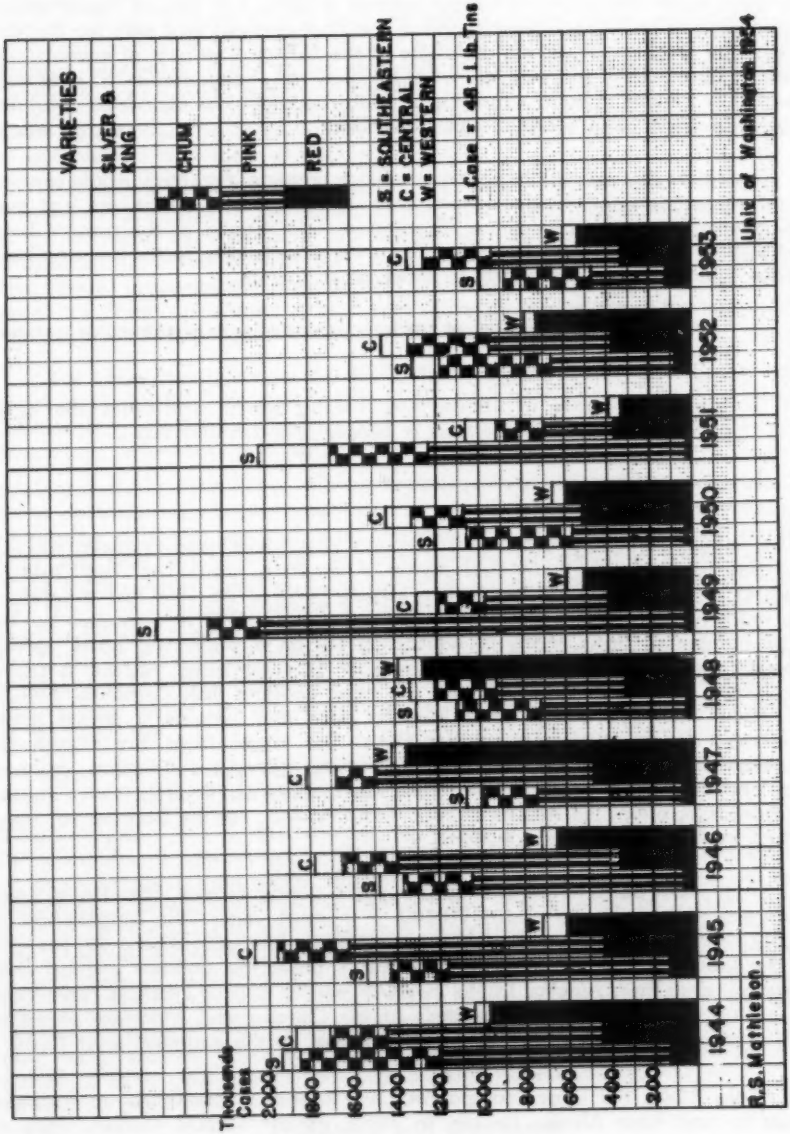


Figure 2. Recent Production of Alaska Salmon by regions and varieties.

The uncertainty of the salmon run, the short productive season, and the dominance of outside capital and labor have not contributed to the stability of the industry. The development of fishing ports in Alaska has been extremely tardy. The gamble that attends the two- or three-week season " . . . is not conducive to the building up of local industries nor a resident fisherman population." (10) Nor is the gamble favorable to efficient operation of small canneries, as in the hustle and bustle quality control is difficult, and even a minor breakdown of the canning line assumes an altogether untoward interruption in the pack with serious economic consequences. Moreover the capital outlay required to conduct the productive phase of a year's business in a few weeks is considerable.

Economic difficulties for the packers also arise from the closed-season regulations of the Fish and Wildlife Service. Not only are fishing operations restricted but a delayed opening may lead to a refusal on the part of the packers to accept legally caught fish because they are too far advanced toward the spawning stage to be suitable for canning. This is particularly the case with the Pink and the Chum which spawn near the rivers' mouths.

The Service has also limited the intensity of fishing to promote sufficient escapement and spawning. A 1950 investigation of 119 salmon streams in the Prince William Sound-Copper River districts established that seeding of the spawning-beds was excellent in only 8, good in 23, fair in 19, and poor in the remaining 89. (11) One of the causes of over-intensive fishing is the use of certain types of fishing gear, the effectiveness of which may be rated as follows: 1. traps, 2. seines, 3. gill-nets and 4. troll-lines. All of these methods of taking salmon are legal in areas specified by the Fish and Wildlife Service. Traps account for about 40 per cent of the catch, and purse seines for 35 per cent (12). The trap is particularly in ill repute as a factor in declining runs. The Alaska Fisheries Board and former Secretary of the Interior Ickes have ". . . publicly recommended the elimination of salmon traps . . .' (13) Undoubtedly if the decline of the salmon runs is caused by overfishing then the trap and the purse seine are contributory causes. Other, less publicised, causes are illegal fishing and the improper timing of closed seasons by the authorities.

When the distribution economies of the industry are considered, Seattle's role as the "principle port of Alaska" becomes evident. In recent years from 10 to 15 per cent of the northbound freight and from 75 to 85 per cent of the southbound freight tonnage carried by three commercial steamship companies serving Alaska arose from fishery requirements. The Territory's salmon shipments account for a very high proportion of the southbound consignments. Seattle is the principal distribution center for canned salmon. The port also has two can-manufacturing plants from which the packers receive their supplies.

Rising freight rates and shipping tie-ups in postwar years have been an element in the rising price of canned salmon. Attempts have been made to ship frozen salmon by air, but the ruling freight rates are still too high for economic distribution by this means.

## Prospect

The future prospect for the salmon industry would appear to be very poor. It might be implied that an industry drifting in economic doldrums is in no position to trim sail and seek new ventures. Nevertheless the man-made problem faced by the industry can only be solved by man's endeavors. The overwhelming requirement is the restoration of the salmon stock. Inevitably the rehabilitation,

conservation, and research program put into force this year by the Fish and Wildlife Service will require great sacrifice on the part of the industry and indirectly the consuming public. Reduced intensity of fishing and smaller packs in future will mean that canned salmon will be in limited supply for some years to come. From the viewpoint of the industry, the hardship also provides an opportunity. One large company has recognized the economic readjustment which will be necessary in the industry.(14) Following its 1953 losses of $1.282,000 the company seeks to rationalize its position. Essentially the plan is to put a larger volume of pack through fewer plants, and in installing and using fewer units of fishing gear. In this way, unit costs may be lowered.

It seems unlikely that the industry as a whole will be able to rationalize its operations in this way since the small, single-unit canneries can operate successfully only on an all-or-none basis. As a consequence any reduction in the over-all capacity of Alaskan canneries is likely to extinguish the small, financially weak firms. In the long run this could result in control by a few of the larger companies.

A newly developed method of securing mobility between locations is the freezership. This could have important economic consequences for the industry under favorable conditions of fishing. A comparison of the operation of freezerships in Japan and the United States is instructive. In recent years the Japanese have successfully operated freezerships in the North Pacific. (15) In 1953 United States companies operated five freezerships in Alaskan waters. This experiment was not successful owing to high operating and labor costs, and to poor fishing conditions. Nevertheless, given abundance of salmon, the freezership supplying fish to shore canneries would be economically feasible.

Whatever the outcome of the rehabilitation objectives of the Fish and Wildlife Service, the industry itself would be well advised to continue its own research program as it has done in the past. In the final analysis the answer to the problems enumerated must come from a better undestanding of the life and habits of the Pacific salmon and through correlated economic behaviour of the salmon fishers and canners.

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# CONSERVATION OF THE FRASER RIVER SOCKEYE SALMON

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Scientific conservation practices may be said to have "saved" two of the basic marine resource of the Pacific Northwest — the Pribilof Island fur seal and the North Pacific halibut. Conservation studies and regulation based on such studies are now attempting to save the sockeye salmon resources centering largely in the Fraser River watershed of British Columbia. (Figure 1)

The Fraser River from 1897 to 1913 represented one of the most productive salmon fishing areas in North America. It has been said that no other salmon fishery was so speedily developed, so productive, or so speedily destroyed. Sockeye salmon packing in this area reached its peak in the interval from 1901 to 1913, this latter year resulting in a commercial pack of 2,392,895 cases. (Figuure 2). Other high years yielded packs in excess of 2,000,000 cases in 1901 and approximately 1,670,000 cases each in 1905 and 1909. Valuation during these peak years ranged from $10,000,000 to more than $15,000,000. Since 1913 the total pack has been drastically reduced, although with increased prices the valuations have remained high. The year 1946, for example, represented an all-time high of $16,834,000 with a pack of only 611,310 cases, or slightly over one-fourth of the pack total of 1913.

It has been customary to assign this alarming decline to a rock slide at Hell's Gate on the Fraser River. During the building of the Canadian National Railroad through the Fraser canyon in 1913 debris from a major slide was dumped into the river at the narrow Hell's Gate passage. The stoppage was so complete that most of the escapement of that peak year was cut off from the spawning lakes and streams of the upper basin. It is not entirely fair to the railroad builders to place sole blame on them, or to assign any simple single cause to the decline of salmon runs on the Fraser River. The problem is quite complex and an understanding of it and the solutions to it require careful analysis.

Commercial fishing and authentic records of the pack start with the year 1875. In this study the salmon referred to will be limited to the sockeye species **Oncorhynchus nerka**, the most valuable and the best of all the five species of Pacific salmon. These fish, on their way to spawning grounds in the upper Fraser and its tributaries, are taken by both United States and Canadian fishermen. Statistics cited indicate the combined pack from both Canadian and United States waters. From 1875 to 1898 the take was modest, not exceeding 200,000 cases of 48 one-pound tins. By 1889 the so-called historic four-year

Figure 1. The Fraser River Watershed.

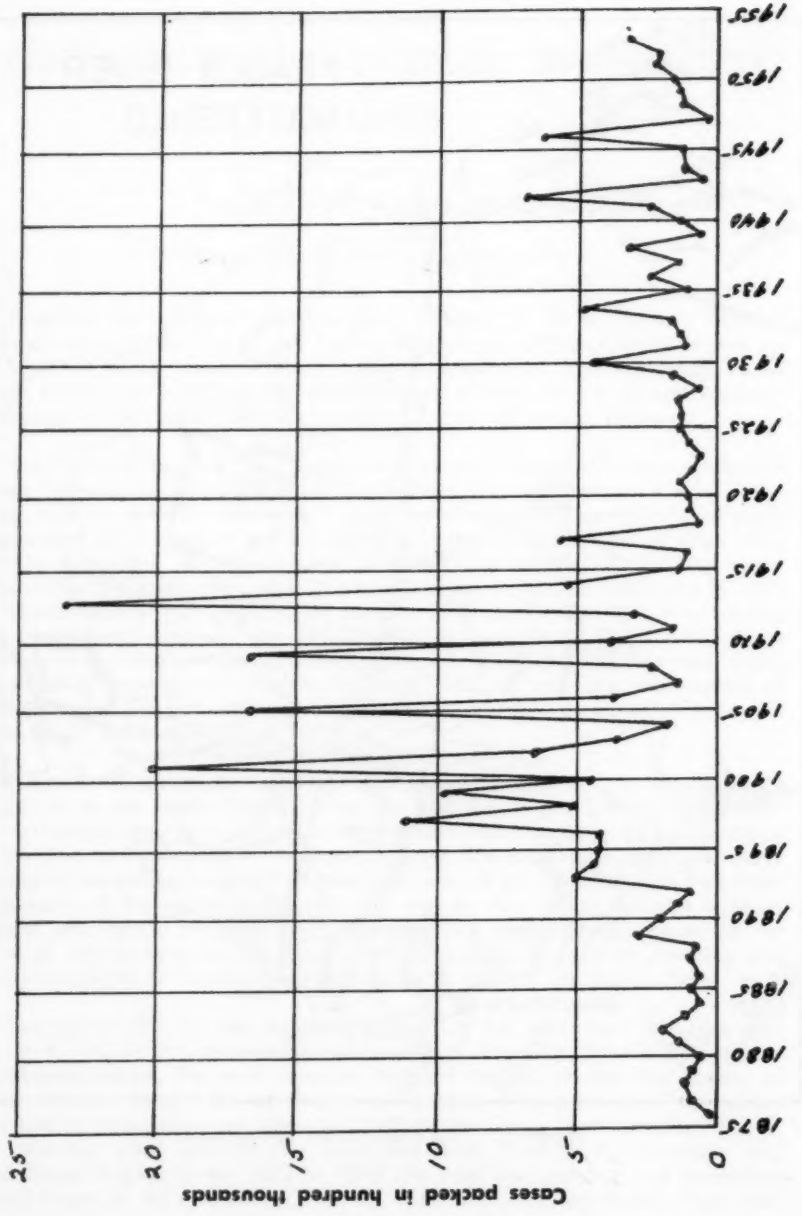


Figure 2 PACK OF FRASER RIVER SOCKEYE — 1876 TO 1953

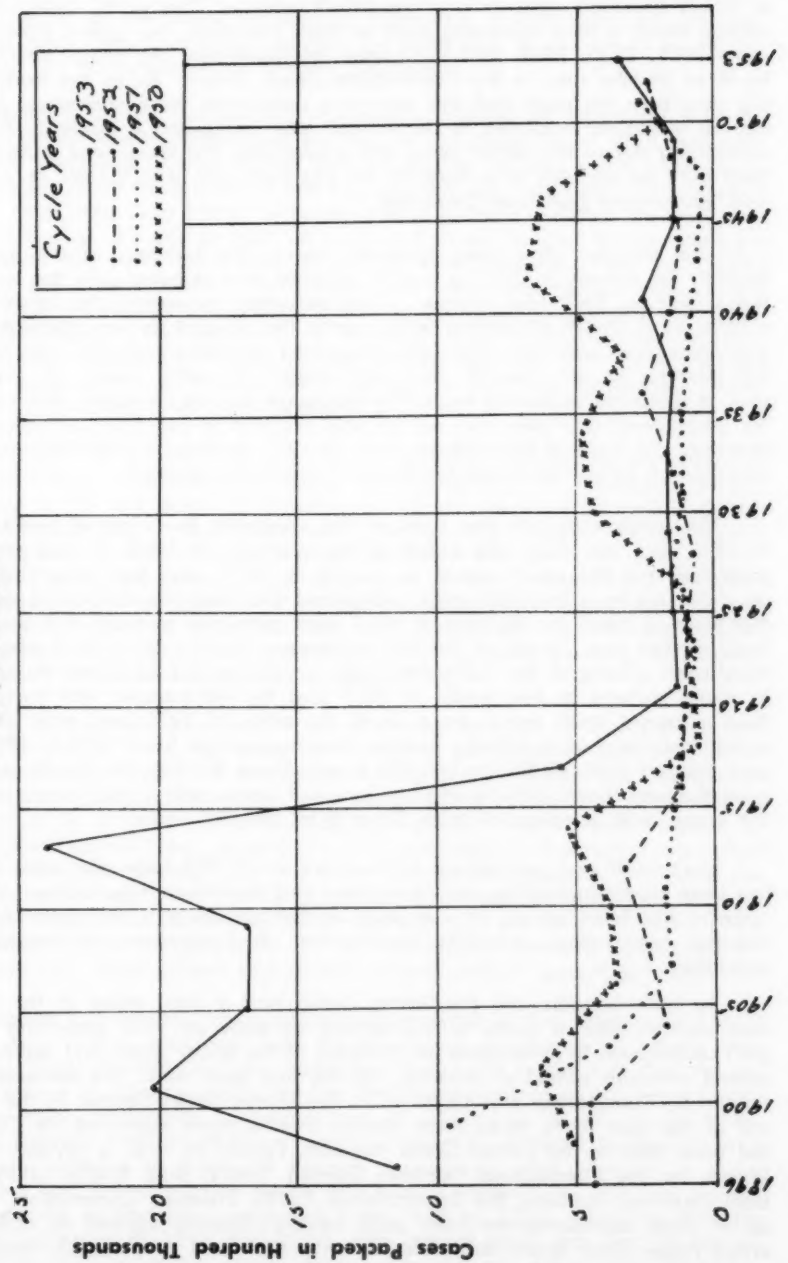


**Figure 3. PACK OF FRASER RIVER SOCKEYE BY CYCLE YEARS**
48 pound cases

cycle was evident, reaching the all-time production total of 2,392,895 cases in 1913, the year generally credited with the big slide. Up to this time the pack of Fraser-spawned sockeye was dependent upon a "big year" cycle, as the salmon return to their spawning beds as adult fish every four years, interrupted years 1901, 1905, 1909, and 1913 were the traditional big years, interrupted by three smaller runs in the intermediate years. (Figure 3). In the traditional big year both the pack and the spawning escapment were enormous. A few marine biologists interested in the salmon runs recognized a tendency toward overfishing during the leaner years and argued that the lesser runs could have been built up possibly to a level of the big year runs if a greater or even a total escapement had been permitted.

As the popular story goes, however, during the building of the railroad through the canyon in 1913 a major rockslide was dumped into the river at Hell's Gate, a swift and narrow critical passage, increasing the length and velocity of a stretch of boiling white water that sluiced its way through. Migrating sallmon can leap over some amazing falls and rapids, but they lacked the strength to get through the long stretch of swift water, at least in time to reach the spawning beds. The stoppage was so complete that most of the escapement that year was cut off and millions of fish perished below the blockade. As a result the sockeye pack of 1917 dropped to 500,000 cases, a reduction of 70 per cent, and the big year cycle was ended.

The number of fish that reached the spawning beds above Hell's Gate in 1913 was less than one-eighth of the numbers in 1909. It was speedily predicted that the result would be shown in 1917, and the forecast proved accurate. Again a few biologists recognized that had the 6,000,000 sockeye that went to make up the pack of 1917 been permitted to reach the spawning beds in that year, much of the loss occasioned by the 1913 blockade could have been recovered. But fishermen and canners spared no efforts to capture as many sockeye as they could in 1917 and the escapement was no greater than in recent small years. As a result the catch of 1921 was only 142,598 cases. From then on conditions became even worse and from 1918 to 1929 the pack ranged from 70,420 to 158,980 cases. Many felt that the Fraser sockeye were doomed. From 1930 to 1946, a new but lower cycle of big years entered the scene, with a range of from 321,435 to 690,437 cases.

Since 1947 and perhaps an all-time low of 35,930 cases, the annual take has been slowly increasing, and it appears that the Fraser river sockeye salmon industry has been saved. (1) The story of that salvation is the story of international cooperation, scientific investigation, and measures of conservation regulation.

As both Canada and the United States had a vital stake in the Fraser river salmon runs, a treaty was proposed as early as 1907 providing for a joint commission to investigate the problem of the lesser years and recommend control measure aimed at building up the low year runs. The measure was passed by Canada but was defeated in the United States Senate. In the interval of the next thirty years three similar treaties were approved by Canada, but were held up by United States interests. Finally in 1937 a revised treaty, known as the International Sockeye Salmon Treaty, was finally ratified by both countries, creating the International Pacific Fisheries Commission, made up of three representatives from each country. Canada agreed to make the entire Fraser River Basin available for restoration and propagation work, the cost to be borne jointly.

The Commission was empowered to investigate the natural history of the sockeye salmon of the Fraser River in all of its aspects, to recommend the building of fishways, removal of barriers, improvement of spawning grounds, restocking of barren areas, as well as restrictions or limitations on the commercial catch from Convention waters. The catch was to be shared as equally between the two countries as proved practicable.

Research started immediately revealing a number of significant findings. It was noted that the attempted removal of the rockslide in 1914 was only partially successful. It was further discovered that at low water levels some of the runs, particularly those of late fall, got through, but that during times of heavy runoff the long stretch of high velocity water prevented the fish from getting through. As late as 1941 an estimated 65 per cent of the sockeye were lost below the Hell's Gate raceway during a high water stage that lasted through two critical months. This observation apparently helped explain why on at least three occasions since 1875 a regularly established big year cycle suddenly ended to be replaced by a new one. This finding also partially exonerates the Canadian National Railway and the slide of 1913. Critically high or low water both can become effective barriers. The slide apparently merely added to an already difficult condition.

In 1945 the Commission published a technical bulletin on the effects of the Hell's Gate obstruction, prepared by Dr. William F. Thompson, fishery biologist at the University of Washington, which corroborated and extended the conclusions stated above, and which became the blueprint for a program of corrective action. (2) This report emphasizes that there are only two explanations for the depletion of the Fraser River sockeye. One is overfishing, the other the obstruction of the canyon at Hell's Gate, presumed effective for but two years, 1913 and 1914. Rock dumping merely increased the difficulty of passage at this and other points. Hence overfishing and resulting inadequate escapement remains as a significant cause.

The first serious jamming of the migration passage at Hell's Gate was noticed in July of 1913. By October a temporary passageway had been blasted through. This work and the falling water level permitted the passage of considerable numbers of salmon and explains the presence of remnants of a big year in 1917. On February 23, 1914 another serious slide occurred at Hell's Gate. Removal was started almost immediately but was not completed until a year later. During 1914 the water was again unusually high and the main summer runs were unable to make it through. Delayed and difficult passage periods are apparently quite common and are likely to occur every few years. There is apparently a close correlation between spawning escapement and water height and velocity during critical spawning months.

Records indicate two major periods of depletion in the commercial history of the river. One is associated with the beginnings of commercial fishing from 1875 to 1903, in which the low yield was owing not to the fact that the industry was in its infancy, but to the fact that large numbers of fish were simply not available. Apparently sometime prior to 1875 a series of critical conditions in the river had resulted in a selective depletion, assisted by the existence of a dam without an adequate fishway passage to Lake Quesnel, a major spawning bed, an obstruction which was finally removed in 1921. The second major period of depletion occuurred from 1913 to 1929, following the aumented blockings of 1913 and 1914. This second perid was not caused by a slide in 1913, since the really serious slide did not occur until 1914, fur-

ther reducing the emphasis on railroad contruction or other human causes. Similar critical conditions in the river occurred in 1941, threatening similar results. It was obvious that if the Fraser salmon were to be saved, plans must be put into effect to make it easier for migrating salmon to make the passage through a number of swift water obstructions. In all some 37 obstacles or points of difficult passage were found, including the major point at Hell's Gate.

Concluding that the Hell's Gate blockade should be regarded as a permanent obstruction and the major critical point, the Commission decided to attack it first with a permanent remedy — the building of concrete fishways on both sides of the canyon. Work was begun in 1944. The first way was ready for the run of 1945, and both were in operation in 1946. Success was immediate. For the first time since 1913 salmon in maximum numbers were able to reach the spawning beds and in better physical condition than was unusual. The escapement of 1945 and 1946 was approximately four times as large as in the previous cycle years of 1941 and 1942.

Both Hell's Gate fishways, together with fishways at each of the two Bridge River rapids farther up the river, were in operation for the 1946 season. The entire construction up to this point had cost less than $1,000,000. Meanwhile the loss of fish since the original blockade in 1913 and 1914 was estimated at half a billion dollars.

Water levels were high in 1945 and 1946, which could easily have been disaster years, yet a good escapement was effected. In 1946 the four fishways then in operation demonstrated their effectiveness in a most gratifying manner. In 1947 the Committee was able to report that the effect of the completion of even one ladder at Hell's Gate resulted in 1945 in an increase of 370 per cent in escapement with 1946 showing an increase of over 240 per cent.(1)

The Commission now began planning additional fishways, prepared to remove barriers, and restock formerly productive lakes and streams now virtually barren. Restricted catches to insure liberal escapements were also part of the rehabilitation plan. The ultimate objective was set for a steadily augmented return of adult salmon until all runs were rebuilt to profitable size, enabling the Fraser basin to become the world's most productive salmon area.

In 1947 work was started on this second phase. In 1949 an escapement count was made at Stuart Lake, a representative spawning area. In 1945 the number of spawning fish here was checked as 7,081. In 1949 some 80,500 were in the area. That same year the fishway at Farwell Canyon on the Chilcotin River was completed and was in operation for the 1950 run.

The 1951 run should normally have been the lowest of the four quadrennial runs since the early days of the fishing industry. Severe restrictions had been placed on the catch of 1947. Channelway improvements and this catch restriction resulted in a maximum escapment for a poor year, and as a result over 252,500 cases were packed in 1951. Further improvements at Hell's Gate were effected that year, through the addition of a high level fishway designed to facilitate passage for early runs when the water is so high as to completely cover the earlier fishways. The high level channel is 190 feet long and nine feet wide. It consist of a channelway where the current is retarded by a series of concrete vertical baffles. Free access to the leading

spawning and rearing areas of the Fraser has now been achieved and rehabilitation of barren areas continues.

By 1952 the Commission expanded its scope of responsibiliy into the field of general regional planning, as consideration now had to be given to requests for hydro-electric power sites, and other resources in the area. Thousands of acres of potential agricultural lands needing pump irrigation are considered feasible for use without endangering the fish program. Lumber companies are asking for more and more timber to cut, planning to exceed the billion board feet cut in 1951. Settlers are slowly coming into the watershed areas. In British Columbia an estimated 15,000,000 horsepower of hydroelectric energy, half of it in the Fraser Basin, could be developed without hindering the salmon program, if properly planned. Even pulp mills could be encouraged if the problem of waste disposal is properly handled. But the Commission is jealous of its accomplishments in salmon rehabilitation and regards the fishery program as having prior claims over all other uses.

Meanwhile the 1953 report continues in an optimistic vein. (1) In spite of rather severe regulations, record harvests have been taken by Fraser waters sockeye fisherman for three consecutive years. In 1953 the catch exceeded that of any previous cycle year since 1917 and the escapement was the largest since 1913. The 1952 run was the largest of that four-year cycle since 1912. In 1951 the catch was the largest for that cycle year since 1903. The increase in this source of wealth during these three years over the preceding cycle years was approximately $18,000,000, a good return for slightly over $2,000,000 invested to date in the rehabilitation program. The 1950 cycle was low and somewhat disappointing, owing to poor survival of fingerlings and low escapement in 1946. It was however, carefully controlled to assure substantial escapement. The commission predicts that although 1954 would not be a large run year, an increase would be noted. By the end of August, 1954, it became evident that this highly conservative prediction would be exceeded beyond all expectation. Seattle papers on August 31 were carrying stories of a huge catch that was swamping canneries in the convention area. The August 30 catch ran nearly a million fish worth roughly $2,000,000 to the fishermen. Sockeye bound for the Adams River spawning beds in the two weeks prior to this date had numbered 4,500,000, and fisheries officials were beginning to believe the run would bring in the biggest U.S.-Canadian catch of sockeye since 1913. As this **Yearbook** went to press the season was not yet over, but confidence was expressed the 1954 run would easily exceed 700,000 cases. Meanwhile rehabilitation of barren areas continues through plantings and barrier removals, and the Fraser River is becoming, as planned, the world's greatest salmon river. It is hoped that all runs will be fairly even now, without sharp contrast in big years and poor runs, but all years are expected to continue with a record of gradual increase. Perhaps these modest hopes will be exceeded. The International Pacific Salmon Fisheries Commission is quite sure, in any case, that its major task is completed and that the Fraser River sockeye have been saved.

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# THE PHOTOSYNTHESIS POTENTIAL OF THE ENERGY COMPONENTS OF CLIMATE

Robert W. Pease

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There is need for quantitative measurement of the energy components of climate, especially as they apply to plant growth. Precipitation is measured as a quantity, but temperature gets only numerical description, and light is usually ignored. Quantitative measure of these components would seem as desirable as for precipitation, and a method for making it should be a useful addition to the techniques of climatic study.

The following is a preliminary report of thought in this direction.

Several systems for relating temperature to plant growth have been devised. They have not received widespread use, however, for they do not achieve good correlation with nature and are awkward to use. In general:

1. they fail to recognize all cardinal points of plant temperature response,
2. they assume all plants have the same temperature response,
3. they do not consider daily range of temperature which varies results significantly,
4. last, but not least, they do not consider the light factor, and thus are only partially rational with nature.

A plant does not directly respond to energy as a "quantity", and thus usual direct energy measures, such as the gram-calories, will not suffice. Instead, it responds to energy "intensity" and the rate of its reaction is in accordance with illumination and temperature. We are here concerned with measuring the "effect" of energy, rather than energy itself, and a unit of measurement would involve the "rate of response" over a time period. It might well be an hour of maximum response, or its equivalent in hours of partial response.

The simplest but least accurate application of this approach considers temperature response only, but, unlike earlier methods, takes into consideration the daily march of temperature. If growth at the optimum temperature is taken as unity, and if the fractional response at other temperatures is known, the growth value of hourly temperatures of any daily march can accumulate into the "equivalent hours of maximum growth" for that day. Temperature response curves for a number of crop plants have been derived experimentally. The most used is Lehenbauer's curve for corn seedlings.(3) With such physiologic curves and with appropriate climatic data, monthly and yearly growth potentials for any site can be accumulated in the above temperature-growth response terms.

Temperature-growth summations fit nature's reality only moderately well, however, for they omit the light factor. They will not show, for example, the

rapid growth which occurs in the long days of high latitude summer, or the inhibiting effect of excessive cloudiness. Further, growth is primarily concerned with the vegetative phase of a plant's life cycle and may be only indirectly related to crop yield. The validity of its use hinges upon the fact that in its terminal position in the physiologic sequence growth summarizes environmental forces acting on the plant. Growth cannot occur, however, when food is not available; so would it not be more valid to apply climatic controls to the food-making process itself, that is, to photosynthesis, This makes possible the consideration of the light factor and, further, the inhibiting effect of plant respiration. In fact, carbon dioxide fertilization experiments demonstrate that photosynthesis correlates closely with crop yields.

To understand better how this can be accomplished, let us review briefly this food-making process. Water absorbed by roots is translocated to leaves where, in intercellular spaces, it mixes with carbon dioxide gas from the air. The carbonic acid thus formed osmotically enters specialized leaf cells where, in the presence of light, it is converted into the plant food, sugar. The complete process consists of several sub-reactions. One of these requires light, is photo-chemical in character, and is termed the "light reaction". The others are strictly chemical in character and are termed "dark reactions". Essentially, the light reaction responds to light intensity, but not to temperature, while the dark reactions are sensitive to temperature but not to light. The energy components of climate directly control the rate of the process by their respective influences on these sub-reactions.

The carbon dioxide enters the intercellular space through minute pores, or stomata, in the leaf skin membrane. Since carbon dioxide supply is directly related to the rate of the process, the aperture of these pores is important, and since aperture is controlled by a pair of photosynthetically operated guard cells, light and temperature have further indirect influence as they exert joint control at this point.(5)

There is no universal agreement among plant physiologists as to the ratio of light to temperature in either direct or indirect control. Two general concepts exist. One, the bottleneck concept, assumes sole control by the most deficient factor. The other, the functional concept, assumes all factors control in proportion to their relative deficiencies. Rabinowitz (4) suggests that functional control is in order when two influences are acting on the same reaction, but the bottleneck type of control occurs when they act on different reactions in a reaction chain. Light and temperature act on different sub-reactions, but since light reactions cannot proceed faster than the following reactions can handle their products, nor can the dark reactions proceed more rapidly than raw material is supplied to them, light and temperature assume the functional relation.

In nature, the most deficient factor influencing photosynthesis is carbon dioxide, for its supply depends upon the minimal concentration in the air. But, since it exists in fairly uniform quantities, it essentially provides a limiting framework within which light and temperature act. A result of this three-way control has been that the effect of temperature has been particularly disguised, which has minimized its importance to many plant physiologists.

Experimental evidence substantiates the functional control. On one hand it has been demonstrated that temperature is most felt at high light intensities, (1.2.) whereas at high temperatures light is the controlling factor. (5) Both are

compatible with a simple "light times temperature" control, for if maximum response is taken as unity, the greatest variation below maximum will show he greatest overall effect. If then, the photosynthesis efficiency of temperature is expressed as Te, and illumination efficiency as Ie, the overall photosynthesis efficiency will be:

Pe-Te x Ie

This relationship appears overly simple perhaps, but only because it requires the use of appropriate temperature and light response curves which in themselves are too complex to be readily stated as algebraic formulae. Thus used it produces daily curves of photosynthesis which closely compare with those experimentally derived.

One characteristic of daily curves of photosynthesis is a mid-day decline which often amounts to a complete cessation of food-making activity. The exact cause of this is not perfectly understood, but it always seems to occur at fairly high temperatures. Decline in activity is often rapid and complete, as would result if unfavorable water balance in the leaves were the cause. Such a water deficit could result from rapid transpiration at high temperatures or more significantly, from vegetative growth else where in the plant. It has now been demonstrated that this growth occurs most rapidly during the warm hours of mid-day at the expense of more mature cells. This suggests that the temperatures most conducive to vegetative growth actually hinder food production. This is in keeping with the well-known experimental phenomenon that the optimum temperatures for plant growth decline with longer exposure to high temperatures. At first a plant grows rapidly on stored food, but as this is used it must fall back on immediate food production, or to a temperature which allows food production to balance growth. This would be the photosynthesis temperature optimum and would approximate the growth optimum of long duration. A temperature response curve with an appropriate temperature optimum and super-optimal decline will rationally reproduce the mid-day declines by the simple light-temperature relation previously stated.

## The Method

Calculation of hours of maximum photosynthesis is made in three steps. The first involves the computation of a base value which accounts for temperature variations, but which maintains factors of illumination at a fixed condition. The second involves the modification of the base or temperature value according to light conditions, variations of which result from noon sun altitude, day length, and cloudiness. The third step involves the subtraction from the photosynthesis potential of the food consumed by respiration which is particularly significant under climatic conditions were warm nights prevail.

To perform the first step it is necessary to establish average temperatures for each daylight hour. Since standard climatic data furnish maximum, minimum, and average temperatures for a 24-hour period, it is necessary to assume standard daily temperature curves from which the hourly temperatures for the daylight hours can be derived. The photosynthesis efficiency of each hours's temperature is then obtained from an appropriate temperature response curve. Since all plants do not have the same response, most accurate results would be obtained if curves for specific plants could be used. Since these usually are not available, choice can be made of one of the three general curves shown in Fig. 1. In a general way, these fit cool temperate, warm temperate, and topical plants and crops.

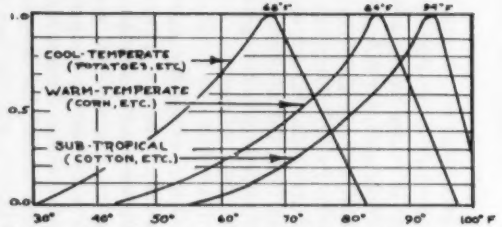


Figure 1. General Photosynthesis temperature response curves for various crop plants.

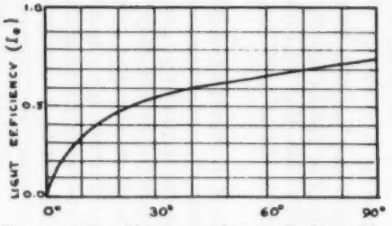


Figure 2. Photosynthesis light efficiency of sunlight falling on a hemispherically shaped plant, according to sun altitude.

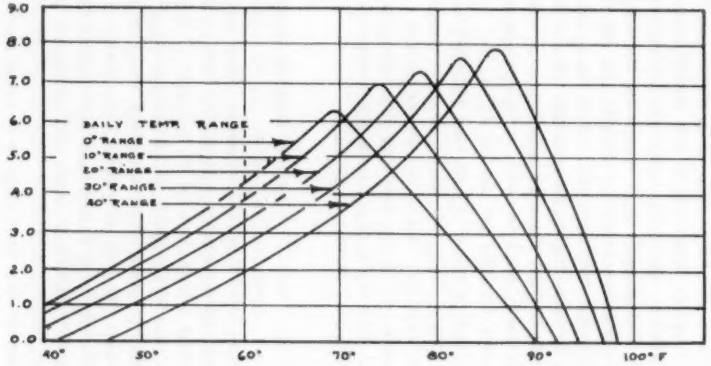


Figure 3. Daily equivalent hours of maximum photosynthesis according to mean temperature and range of temperature for warm-temperate plants, a 12 hour day, and 90° noon sun altitude.

| | 1. MEAN TEMPERATURE | 2. AVE. DAILY TEMP. RANGE | 3. HRS. MAX. PHOTOSYN. 12 HR. DAY - 90° SUN | 4. SUN ALT. CORRECTION: SUN ALT. | 4. SUN ALT. CORRECTION: FACTOR | 5. DAY LNGTH. CORR.: DAY LENGTH (HRS.) | 5. DAY LNGTH. CORR.: FACTOR | 6. CLOUDINESS CORRECTION: % OF DAYS | % OF CLOUD | AVE. % PER MO. | FACTOR | 7. DAILY TOTAL | 8. MONTHLY TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| JAN. | 55° | 19° | 2.0 | 35° | .68 | 10.5 | .88 | .20 | x 100 | = 20 | .93 | 1.12 | 35.5 |
| FEB. | 56° | 19° | 2.1 | 43° | .73 | 11.1 | .93 | .25 | x 100 | = 25 | .90 | 1.20 | 36.0 |
| MAR. | 57° | 19° | 2.2 | 53° | .81 | 12.0 | 1.00 | .20 | x 100 | = 20 | .93 | 1.44 | 46.7 |
| APR. | 60° | 19° | 2.8 | 63° | .87 | 12.8 | 1.09 | .25 | x 50 | = 12.5 | .97 | 2.52 | 76.2 |
| MAY | 62° | 19° | 3.0 | 73° | .92 | 13.6 | 1.18 | .50 | x 50 | = 25 | .90 | 2.94 | 88.0 |
| JUN. | 66° | 19° | 3.9 | 79° | .95 | 14.0 | 1.21 | .50 | x 50 | = 25 | .90 | 4.05 | 121.0 |
| JUL. | 70° | 21° | 5.2 | 77° | .93 | 13.8 | 1.19 | .10 | x 10 | = 10 | .98 | 5.10 | 153.0 |
| AUG. | 71° | 20° | 5.2 | 70° | .90 | 13.2 | 1.12 | .10 | x 10 | = 10 | .98 | 5.20 | 156.0 |
| SEP | 69° | 20° | 4.8 | 59° | .83 | 12.0 | 1.00 | .10 | x 10 | = 10 | .98 | 4.06 | 122.0 |
| OCT. | 65° | 20° | 3.8 | 48° | .78 | 11.5 | .96 | .10 | x 20 | = 20 | .93 | 2.65 | 79.5 |
| NOV. | 61° | 22° | 3.1 | 38° | .70 | 10.6 | .88 | .10 | x 100 | = 10 | .98 | 1.88 | 56.5 |
| DEC. | 56° | 19° | 2.0 | 33° | .65 | 10.2 | .75 | .10 | x 100 | = 10 | .98 | .96 | 28.8 |

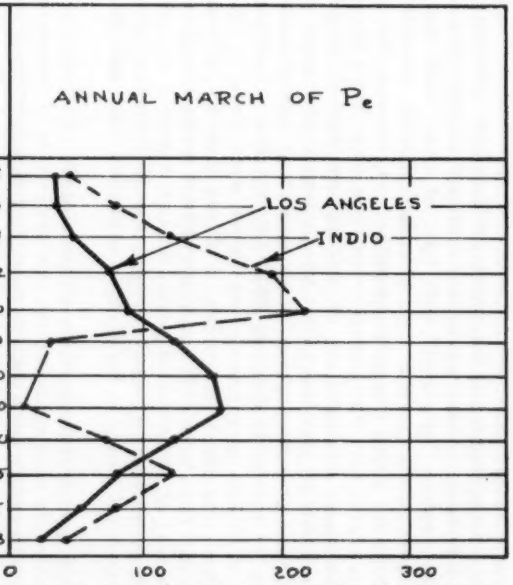


Figure 4. Sample calculation of hours of maximum photosynthesis for a warm-temperate plant at Los Angeles, Calif. Respiration losses are included in column 3. For comparison, Indio, Calif. has been included in the R.H. graph.

Although the first step is primarily concerned with temperature, it is necessary to establish the hourly march of the photosynthesis light efficiency for the standard light conditions. Laboratory experiments indicate that the leaves of sun-loving plants become "saturated" with light at about 2400 foot candles illumination, in atmospheric concentrations of carbon dioxide. Intensities above this have no additional effect. It would indeed be rare, however, for any plant to have all of its leaves fully illuminated at any one time. Some leaves are in the shaded under-layer, and some are on the opposite side of the plant from the sun. Although there are instances of flat canopy leaf cover, the general shape here assumed is that of a hemisphere. If, to account for partly shaded under leaves, we raise the saturation value to 4800 foot candles, it is impossible to achieve overall saturation on a hemisphere shape, even under a 10,000 foot candle direct noon day illumination. Fig. 2 shows that sun altitude affects the light efficency of this shape, first by its geometrical relationship, and second by the lower intensity of sunlight as it passes through a greater air mass. These curves consider both the fill-in effect of skylight, and the flattening which results from the illumination of leaves in the direct sun beyond their saturation point.

By combining light and temperature efficiencies for each hour of any day under consideration, the total consideration, the total hours of maximum photosynthesis for that day can be computed. By many such computations it is possible to construct a nomogram, as in Fig.3, which facilitates making this step.

The second step, which accommodates light variations, is achieved by the application of three correction factors to the value derived in step 1. The first correction, for noon sun altitudes other than 90 degrees, can be derived from the sums of hourly light efficiencies for various noon sun altitudes. The second, day length, is similarly derived from sums of hourly light efficiencies for day lengths other than 12 hours. The third, cloudiness, is derived from experimental photometric data various types and percentages of cloud cover.

The third step involves the subtraction of food consumed by respiration from the photosynthesis potential. As this process is most significant when photosynthesis is inactive, its correction is made for night hours and the hiatus of warm mid-days. As respiration has a temperature relation, a generalized respiration loss can be combined with the basic temperature nomogram to eliminate this step when general calculations are desired.

To accumulate the totals of hours of maximum photosynthesis for long time periods, daily values are computed for the "average" or middle day of each month, which are then multiplied by 30.4 to obtain the monthly total. Monthly totals can be accumulated into yearly totals or can be plotted as the month march off photosynthesis. Such a computation and march are shown by Fig. 4.

## Conclusion

Measurement of photosynthesis in climate terms has significant use. Since it uses standard climatic data, areal differentiations of the photosynthesis potential can easily be mapped. Information it provides might well aid in the analysis of certain geographic problems involving crop or plant distribution. It conceivably could be the basis for a new type of vege-climatic classification. And the nature of the annual march of photosynthesis has climatic implications that could be of particular interest in crop planning. These are probably but a few uses for the method is still in a formative stage. It is subject to revision

and change, but even in this initial form it seems to correlate suprisingly well with nature. If perhaps it seems too complex for geographic use, let us consider that only as geographers duplicate nature's complexity will their results fit nature's reality.

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# SEVENTEENTH ANNUAL MEETING

**Pullman, Washington, June 24-26, 1954**

The seventeenth annual meeting of the Asociation was held at Washington State College, in conjunction with the annual meeting of the Pacific Divison, American Association for the Advancement of Science. Four half day sessions were devoted to the presentation of research papers, with a business meeting included on Friday morning, June 25. An all-day field trip, Saturday, June 26, covering portions of western Idaho, was led by Dr. Harry R. Caldwell, University of Idaho. The address of the retiring president, Dr. James J. Parsons, was delivered on Thursday evening, June 24, at the annual dinner in the Compton Union Building.

## Program, With Abstracts of Papers Presented

W. J. BARRETT, Marine and Steam Terraces of the Southeast Costal Plain of the Dominican Republic. University of California, Berkeley.

The coastal plain consists of a reef deposit of Pliocene-Pleistocene age that lies unconformably on southward dipping Tertiary shales and limestones. These tilted beds are members of a sedimentary series that was uplifted towards the close of the Tertiary to form the Cordillera Central. During the succeeding submergence the reef grew and this event was followed by intermittent emergence which led to the formation of three marine terraces, and three corresponding stream terraces, best developed on the Higuamo, the Soco, and the Chabón Rivers. The three marine terraces cover an area of approximately 125 miles in the east-west direction, and 15 to 25 miles in the north-south direction. The oldest terrace is the most extensive, reaching from the foot of the mountains to within one or two miles of the sea, and forms the most important sugar growing region of the Dominican Republic. The lower terraces, with back edges at about 100 and 30 feet, are narrow and have a thin and discontinuous soil cover that is not of agricultural importance. There is neither escarpment nor beach deposit associated with the back edge of the highest terrace, so the break in slope between the mountains and the coastal plain was taken as the approximate position of the highest sea stand, The altitude of this point is everywhere more than 400 feet. The two lowest terraces have been strongly uplifted in the west, nearer Cuidad Trujillo, and depressed in the southeast peninsula. Evidence of warping of the highest strandline is not so clear.

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SAMUEL N. DICKEN, Conservation in Wallowa County, Oregon, University of Oregon.

Wallowa County in northeastern Oregon is a rather isolated district with a slowly declining population and a fairly stable production pattern. Pressure on the land is moderate and conservation problems are not so serious as those in some other parts of the state.

Grazing began early but over-grazing and the competition of irrigated pastures led to decreasing use of the range lands. Irrigation increased rather rapidly until 1915, after which the increase has been slow. In recent years the dry farmed acreage, mostly wheat, has varied with demand, climate, and quotas. Lumbering began on a large scale with the advent of the railroad in 1907, but has varied considerably in annual cut. Logging must decline in the near future as the private stands of timber are nearing exhaustion. Recreation

is slowly increasing as new roads and tourist facilities are provided. Mining is limited to sand, gravel, basalt tor road material, and limestone.

Wallowa County obviously needs a comprehensive over-all plan with closer coordination of existing conservation agencies in order to cushion the shock of declining lumber production. This can be done by more effective use of the forests and range lands and by increasing irrigation and recreational land use.

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SHELDON D. ERICKSEN, The Western Steel Industry and Related Industrial Employment. University of Oregon. No abstract received.

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OTIS W. FREEMAN, Pioneer Roads of the Inland Empire as Determined by C. S. Kingston. No abstract received, but this paper was published in the October, 1954. **Pacific Northwest Quarterly.**

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WILLIAM L. GARRISON, Rural Roads. University of Washington

The spatial relationship of producers in rural areas over roads to nodal points can be described in a general model. Land value is written as the dependent variable and distance as the independent variable. Land value is measurable and, thus, superior to other dependent variables that might be used. The model describes a linear relationship between real distance and land value.

The model constructed was used to examine three cases of the effects of undifferentiated improvements in roads on the spatial arrangement of land values: (1) a single market, single product case; (2) a multiple market, single product case; and (3) a single market, multiple product case. In each case road improvements dispersed equally over space occasion an unequal distribution of benefits. The model was then used to examine a case when changes in roads are differentiated over space. In the case described by the model, it was shown that the greater the differentiation the greater the benefits.

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JOHN W. GIERHART, The Fertilizer Industry of the Pacific Northwest. Raw Materials Survey, Inc., Portland, Oregon.

The Pacific Northwest fertilizer industry consists of two phases: the production of the primary chemical compounds, and the mixing of these compounds to meet the particular needs of agriculturalists. The market area of the primary producers extends beyond the regional limits, whereas the mixers serve a local market. Primary production in the area amounts to over a million tons yearly, using phosphate rock of the field covering parts of Idaho, Montana, Wyoming and Utah, and sulfuric acid from the stack gasses of the smelters in the region.

The Pacific Northwest differs from the rest of the nation in the kinds of fertilizer used, and the trends in use. Three factors point to further growth of the Northwest market for fertilizer: First, land farmed under reclamation calls for intensification of use; second, government aid and conservation programs encourage greater application of fertilizer; third, acreage limitations under the agricultural commodity control program result in greater use of fertilizer. This paper was published as Infomation Circular No. 6 of the Raw Materials Survey.

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DALE V. GRAVES, Game Bird Cover, A Phase of Resource Management. Washington State Game Commission, Seattle. No abstract received.

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OLIVER H. HEINTZELMAN, Longview, The Planned City. Oregon State College. No abstract received.

R. M. HIGHSMITH, JR., Irrigation in the Willamette Valley. Oregon State College. No abstract received.

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J. ROSS MACKAY, Glacier Ice Movement in the Amundsen Gulf Area, Northwest Territories, Canada. University of British Columbia.

The movement of glacier ice in the Canadian Arctic is imperfectly known. The generally accepted view is that ice from the huge Laurentide Ice Sheet spread northward from the mainland of Canada to engulf the southern and eastern Arctic Islands. In the light of new evidence derived from field studies and photointerpretation, this paper re-examines the movement of glacier ice in the Amundsen Gulf area and re-interprets the post glacial limits of marine submergence along the mainland coast west of Coppermine.

Evidence from linear features in glacial till and bedrock, together with the trend of end moraines, meltwater channels and eskers, all suggest that glacier ice pushed landward from Amundsen Gulf across Parry Peninsula and also penterated a few miles inland in the Darnley Bay area. It is suggested that the Mackenzie Delta region has undergone little postglacial emergence and that the amount of emergence east of the delta as far as Darnley Bay has not exceeded a few hundred feet.

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DONALD D. MACPHAIL. Pastoral Land Use Changes in Southern Puerto Rico. Western Washington College of Education.

The pastoral land use changes in southern Puerto Rico give some idea of the transformation in land utilization during the past half-century. The cattle industry has always been an important element in the economy of the commonwealth. Spanish, African, and Asiatic breeds were introduced to improve the quality of the cattle at various stages in the island's history. The grazing lands along the southern coast were regarded as the best in the Greater Antilles. The original incentive was the export of hides, but by 1905, the main interest was raising working livestock for Cuba's sugar plantations.

The Public Irrigation Law of 1908 stimulated changes in the southern grasslands. About 50,000 acres of the region's best pastures have been converted to irrigated sugar cane, and 25,000 additional acres are now in the process of this change. Only the unirrigable foothills and valleys have remained in pasture in a belt of land lying between the forest of the Cordillera Central and the coastal lowlands.

The mechanization of farming in the region has released many pasture lands formerly needed for the upkeep of work oxen from the sugar farms. By crossing European dairy breeds with tropical Asiatic cattle, dairying has become the second most significant agricultural industry of the island, and the southern graslands produce one quarter of Puerto Rico's fluid milk supply. Advancing technology, improved transportation, expanding local markets, and a large-scale public utility program have been some of the basic causes for the recent changes.

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HOWARD H. MARTIN, The Service Industries in Urban Evaluation. University of Washington.

As urban phenomena, the service industries have received scant attention from geographers. Since there is no general accord concerning methodology, one practical approach might begin at the village level. One aspect of a survey conducted in Community X, a typical Corn Belt village of 300, with a prosperous but not rich farm hinterland, was directed toward the increase in

home use of mechanical equipment since 1903. In 1953 the average resident, whether villager or farmer, had or expected to acquire in the near future a bathroom, electricity with numerous gadgets, refrigerator and deep-freeze, radio, television, and was considering air conditioning. Dial telephones, motor cars, and all-weather roads were taken for granted, as were the services of doctor, dentist, hospital, and beauty parlor.

This multiplication of media for better living in Community X has created multiple service needs, now the prerogative of skilled artisans — automotive, electrical, plumbing, refrigeration, and television. Such servicing is a necessity, with the county seat, 14 miles distant, as the recognzed central place from which to obtain it.

The non-administrative functions of the county seat fall into three groups: first, **Trade,** the buying and selling of commodities; second, **Service: Professional,** including the doctor, dentist, attorney, and other consultants; third, **Service: Artisan,** including the burgeoning array of technicians and maintenance men for mechanized homes and their equipment, as well as for auto repair, road work, telephones, water services, and electric power lines. Economically the county seat depends less on administration than on the size, number and buying power of the several smaller X-Communities to which it supplies goods and service.

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RAYMOND S. MATHIESON, The Alaskan Salmon Industry, Prologue and Prospect. University of Washington. Published in full in this issue.

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WILLIS B. MERRIAM, Conservation of the Frazer River Sockeye Salmon. Washington State College. Published in full in this issue.

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DONALD W. MEINING, The Evolution of Understanding An Environment: Climate and Wheat Culture in the Columbia Pleateau. University of Utah. Published in full in this issue.

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FLEMING S. MOORE, Assam, India's Political Anomaly. University of Washington. No abstract received.

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ROBERT W. PEASE, The Photosynthesis Potential of the Energy Components of Climate. University of California, Los Angeles. Published in full in this issue.

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ANTHONY SAS, The Iron and Steel Industry in Vancouver.

It is rather unlikely that the hopes for an integrated steel industry in British Columbia will be realized in the immediate future as the relative lack of iron and markets makes such an industry hardly feasible. Iron ores of the magnetite variety are to be found only on Vancouver and Taxada Islands, with small reserves only. These ores presently are entirely exported.

The present annual need for steel in British Columbia is estimated at 250,000 tons, of which one quarter is supplied by the province's nine steel manufacturing plants. Only scrap material is used in predominantly electric

converters. Three quarters of the annual need has to be imported, but high freight rates make the price of imported steel fairly high.

The realization of proposed settlement and industrial plans for Northern British Columbia, may well create added demands for iron and steel products and already several B. C. firms are undertaking the modernization and expansion of their plants, and conducting experiments in concentrating local ores for future home use.

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JOSEPH E. SPENCER AND ROBERT W. PEASE, An Inquiry into the Nature of Rice as a Crop Plant. University of California, Los Angeles.

Rice is widely described as a native of the wet landscapes of southeastern Asia, with recognition that the domesticated plant has spread widely beyond this tropical homeland. Wild rices actually are scattered through the sub-tropics of southern Asia, Africa, and South America, the majority of species being native to Africa. Certainly not all wild species of rice have been catalogued as yet. Known wild species tolerate widely different climatic and soil moisture conditions. Several characteristics of the plant point to variety and non-tropicalness of native habitat. Hybridization into the present host of varieties is thought by some to have occurred chiefly among wild rices, whereas other evidence points to the domestic rices themselves.

There now are two chief classes of rices among the Asiatic varieties. The soft, glutinous, colored rices are associated with subsistence culture and religious ceremonials. The whitish, starchy, harder rices increasingly have dominated commercial agriculture and inter-regional trade. Varietal difference appear bred into the plant by farmers who have developed types tolerant of shade, salt water, deep water, fields lacking any water cover, a short growing season, and the long-seasoned tropics. But all this variety can hardly come from the domestication of a single wild species. The conclusion seems inescapable that the history of rice dometication may well involve as complex a story of wild plant mixture as that now known to surround the develpment of the wheats.

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ROBERT M. TAYLOR, Some Aspects of Indian Influence in Southeast Asia. University of Washington. No abstract received.

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TUAN Y-FU, Types of Pediments in the San Pedro Valley Region, Arizona. University of California, Berkeley. Published in full in this issue.

# Abridged report of the Secretary-Treasurer

The total membership has increased slightly over last year's total, but in June, 1954, there still were 57 regular and 20 student members in arrears.

Several items of business of significance to members were reported at, or passed by, the business meeting held on June 25, 1954. These are:

1. A motion passed urging that the nominating committee be strongly encouraged to place more than one name on the ballot for at least the offices of president and vice-president.

2. In pursuance to a motion of the 1953 business meeting the Secretary corresponded with Geography Departments in the mountain border states in selective definition of the administrative eastern boundary line of the Pacific Coast Division, Association of American Geographers. This line now has been fixed to include the states of Arizona, California, Nevada, Oregon, Washington, British Columbia, Idaho, and Montana from Bozeman westerly but excluding Great Falls. Acceptance of this settlement still is pending decision by the A.A.G. Council.

3. A motion passed authorizing the creation of a sinking fund to be used for contingencies during years of low income, transfers to and expenditures from to be authorized by the Executive Committee.

4. A motion passed to make a matter of formal record and future practice that the term of office of the secretary-treasurer is a two year term, as has been the practice for the past two terms of that office.

| **Income Deposits** | |
|---|---|
| Bank balance, June 1, 1953 | $469.66 |
| Receipts from dues | 511.00 |
| Yearbook sales | 33.50 |
| Miscellaneous contributions | 14.90 |
| Total Deposits | $1,029.06 |

| **Withdrawal of Funds** | |
|---|---|
| Printing Yearbook, Vol. 15 | $454.41 |
| Postage | 68.70 |
| Printing and duplicating | 53.30 |
| Miscellaneous supplies | 9.06 |
| Outdated check | 3.00 |
| Total withdrawals | $588.47 |
| Bank balance 6-24-54 | 440.59 |

**Officers, 1954-1955**

**President:** Langdon White, Stanford University
**Vice-President:** J. Granville Jensen, Oregon State College
**Secretary-Treasurer:** Howard H. Critchfield, Western Washington College of Education, Bellingham, Washington
**Editor:** J. E. Spencer, University of California, Los Angeles.

## NOTES

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